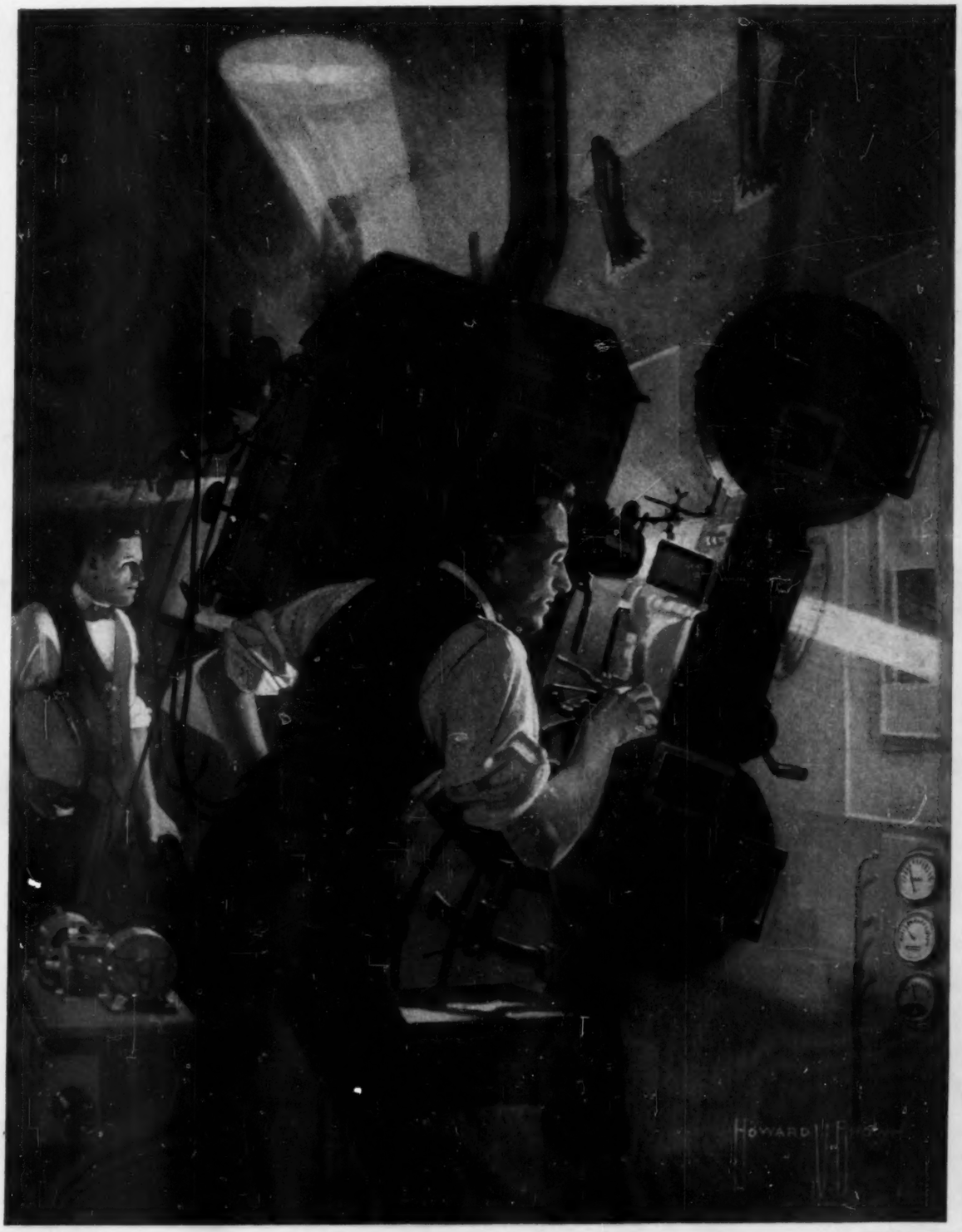
IN THIS ISSUE:

IS IT TO BE BOMB OR BATTLESHIP?
ANIMAL TISSUE THAT DOES NOT DIE

SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS



THE MAN BEHIND THE PICTURE: PROJECTION BOOTH OF A MOTION PICTURE THEATER

Vol. CXXV. No. 1
July 2, 1921

Published Weekly by
Scientific American Publishing Co.
Munn & Co., New York, N. Y.

Price 15 Cents
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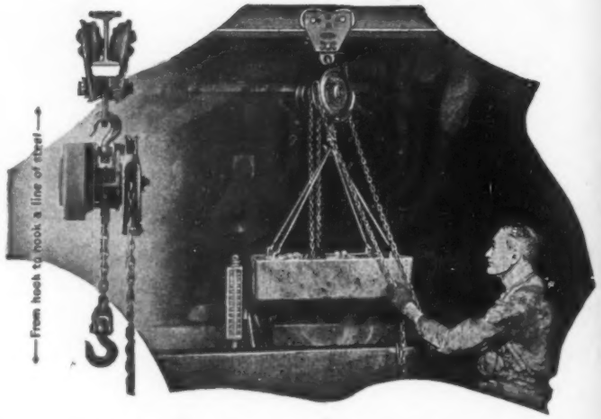
Pocahontas	— — —



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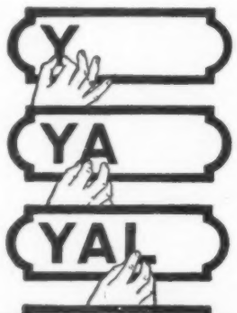

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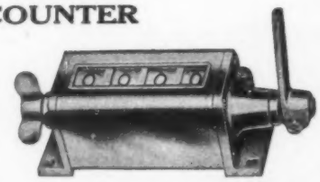

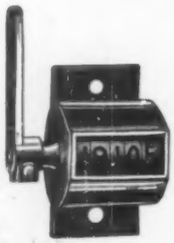

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SEVENTY-SEVENTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXXV. NUMBER 1 | NEW YORK, JULY 2, 1921 | 15 CENTS A COPY 20 CENTS IN CANADA

SOME GRAPHIC COMPARISONS OF OUR CONDENSED MILK INDUSTRY, SUCH AS NUMBER OF CANS AND COWS, VOLUME OF PACKING CASES AND FREIGHT, AND RELATIVE BULK OF RAW MILK AND CONDENSED MILK, TOGETHER WITH CONSTITUENTS OF LATTER—(See page 11)

THE SCIENTIFIC AMERICAN, July 2, 1921. Volume 125, Number 1. Published weekly by Scientific American Publishing Company at 233 Broadway, New York, N. Y. Subscription price, $6.00 per year. Entered as second-class matter June 18, 1879, at the post office at New York, N. Y., under the act of March 3, 1879.

SCIENTIFIC AMERICAN

Published by Scientific American Publishing Co.
Founded 1845
New York, Saturday, July 2, 1921
Munn & Co., 233 Broadway, New York

Charles Allen Munn, President; Orson D. Munn, Treasurer
Allan C. Hoffman, Secretary; all at 233 Broadway

Entered at the Post Office of New York, N. Y., as Second Class matter. Trade Mark Registered in the United States Patent Office.

The Limitations of Aerial Bombing

NAVAL officers point out that there have been appearing in the press with increasing frequency erroneous statements respecting the cost of battleships as compared with aircraft. It is also claimed that aerial bombs are more destructive than gun projectiles, because such bombs contain a larger percentage of explosive than armor-piercing shells of the same size. The statements most frequently made with respect to costs are that 1,000 airplanes can be constructed for the cost of one present-day battleship; that each plane can carry a bomb of sufficient power to sink a battleship; and that the airplane requires a personnel of only two or three men, whereas the battleship requires 800 or more.

In the first place present-day cost of battleships, due to lower prices, is less than $45,000,000; but granting the cost to be that sum, and that such a battleship could be used for the first line for a period of 15 years, and the second line for ten years, at an annual up-keep cost of $1,000,000, the cost of the battleship for 25 years would be $70,000,000, or $2,800,000 yearly. Granted that 1,000 planes can be built for $45,000,000—which, on account of the diversified types required by complete naval air force, seems hardly possible, inasmuch as planes of the larger type cost considerably more than $45,000 each, including their equipment—it should be borne in mind that the life of a plane in service is approximately two years. Hence, the entire cost of the planes must be again spent each succeeding two years, or 12½ times during the life of a battleship; and inasmuch as not less than 50 per cent on the average, of the first cost of a plane is required to keep it in commission for two years, the total cost of 1,000 planes for 25 years would be $843,750,000, or $33,748,000 per year, a sum sufficient to keep in commission 12 battleships of the present-day type.

Furthermore, in the matter of personnel, Naval officers do not agree with the printed statements. A battleship such as contemplated would have a crew of 1,500 officers and men instead of 800, while in the case of airplanes, for every man in the air there is required approximately 20 on the ground. On this basis, 12 battleships would require 18,000 officers and men, and 1,000 airplanes, on the basis of one man in the plane and 20 on the ground, would require 21,000 personnel. To be perfectly fair in the matter, it may be considered that the personnel of the two would about cancel each other in cost, inasmuch as highly skilled mechanics are required on battleships and aircraft alike. In the case of landing fields and hangars for 1,000 aircraft, we may also consider that the expense is canceled by docks and navy yards required for the repair of battleships. That brings the case down to a comparison of material cost, and, as above stated, 1,000 aircraft stretched over a period of 25 years, which is the extreme life of a battleship, would equal the cost of 12 such battleships.

Regarding the statement that aircraft could each carry a bomb sufficiently large to destroy a battleship, it is not believed that at the present day this can be done. Bombs have not been developed to such an extent that they are armor-piercing, and after landing on the deck of a ship their destructiveness would be local. The experiments on the U.S.S. "Indiana" with a large bomb filled with T.N.T. which was exploded on her deck, causing considerable damage to her old-style upper works, has been used as an illustration of what bombs can do, and statements have been made that if the bomb were destructive when laid on the deck, it would be much more so if dropped from an airplane. This is erroneous. The destructiveness of T.N.T., unconfined, has a certain potentiality which is not increased by the mere dropping of the T.N.T. from a height. *It is necessary for the projectile to pierce the armor of the ship and explode inside of her hull.* This cannot be done by thin-walled aerial bombs subject only to the impulse of gravity. There must be acceleration beyond the force of gravity to cause the shell to pierce armor and the shell must be of the armor-piercing variety; consequently, the weight of the shell wall reduces the amount of T.N.T. which it may contain, reducing the destructiveness of the bomb.

It is believed that the actual facts should be given the public. Erroneous comparisons which only bring out one side of the argument do not help the cause of aeronautics but do more harm than good.

The Lampert Bill

THE United States Congress passes, each year, appropriation bills designed to give the various branches of the Government funds for the year's operations. In part these appropriations are a matter of negotiation between the Bureau in question and the Committee of the House of Representatives involved. In equal part they have their basis in statutory provision as to how many men may be employed and at what salaries.

Present salaries in the Patent Office date back to 1848, at which time the patent examiner got the salary of a Federal District Judge. Today the Judge gets $6,000; the examiners have had a single increase of 10 per cent, and a $240 war bonus; they now get considerably less than half the pay of the judges with whom they were once on an equal footing. If comparison of qualifications is to be made, the requirements of the Patent Office are by all means harder to meet. And as for professional dignity, patent examination is in many respects juridical work, and should be compensated as such.

Turning from the question of salaries, we find that the Patent Office is seriously under-manned. Not alone has patent business been increasing by leaps and bounds until it is larger than ever before; the older and more experienced examiners have resigned in large numbers to enter commercial employment or private practice, and it takes two years of continual attention from his superiors to render a newly appointed examiner really competent. This explains why the Patent Office is 46,000 cases behind its schedule, so that if you file an application for a patent today you must wait seven months to get the preliminary report telling what the examiner thinks of it.

The Committee on Patents of the House of Representatives is picked on geographical and political grounds. If it is desired to have a Republican from Maryland and a Democrat from Kansas on this committee, on they go regardless of qualifications to deal with patent business. When a new Congress convenes, the best part of the new committee's time for months is spent in educating its new members—and sometimes its old members—as to what and why is a patent. The hearings of this committee always bring forward some absurd questions from its members, showing fundamental misunderstanding of the entire patent system.

We shall not argue these matters here; we have nothing to add to what we have said in the past. We shall only state that the Lampert Bill, which had a deal of attention from the Patents Committee of the old Congress, is up again in the new one. It provides proper salaries and an adequate staff for the Patent Office. Last time it was talked to death as much by its friends as by its enemies. There is no reason in the world why it should fail this time; and, in fact, it has excellent prospects of passing. When we find that the total payroll of the Patent Office, in the event of its unamended passage, will be but $1,951,840, it is clear that at least the wild cry of "economy" cannot be raised against it. In justice to the inventors and the manufacturers of America as well as to the Patent Office staff, it should be passed.

Relativity in 1889

THE ancients had a pretty myth about Minerva, the goddess of wisdom, whom they stated to have sprung, full-grown and full-panoplied, from the head of Jove. There is more in this legend than appears on the surface. Divine wisdom, perfect and boundless, if we conceive it ever to have had beginning at all, must thus have come into full being. We today should prefer to think of it as without beginning, as having always been, but that may be let pass. The ancient philosophers, at the period when they were still engaged in the personification of their ideas, had without exception failed to grasp the concept of infinite reaches of time—they still felt obliged to account for the beginning and the ending of things.

Human wisdom, unlike Minerva, never springs full-grown into being, but arrives at a given point, if we may mix our metaphors, only by a long and arduous process of toiling up the slopes. In the myth of Minerva the Greeks had in mind this essential distinction between the wisdom of the gods and that of the finite human mind. No single item of human knowledge, no single human doctrine, ever was formulated out of nothing in a single mind. Every such item is the result of slow growth and accretion, and in its final form contains the contribution of many minds. Ultimate formulation is often the work of a single intellect, but this intellect draws its material from the entire past history of the race. The historian of human thought finds it an absorbing business to pursue some great idea back through its ultimate sources. And always when we conduct this search we are amazed by the degree to which the work of the man who is recognized as the originator consists merely in restating in better form, and in a single place, things which have been said before in fragmentary fashion.

The apostles of Einstein, for instance, have realized well that in many respects this relativity of which we are all talking is but another instance of old wine in new bottles. The very phrase "classical relativity" with which so many of them introduce their subject indicates that its fundamentals are by no means new. It is the interpretation of the theory and its unique mathematical formulation that are Einstein's. Nevertheless we are inclined to regard as novel some of its more startling philosophical aspects. Some of them indeed are novel; the General Theory we believe is so; and even in the Special Theory, the assumption that light displays the same velocity to all observers however conditioned could not have been thinkable until twentieth-century physics had given a background of experiment and theory leading to the suggestion. But the very charges of plagiarism brought against Einstein, while absurd in principle, indicate that he has been building with old material to a greater extent than may have been realized. This, we reiterate, is the very nature of things. We must admire those who have supplied the material, who have anticipated parts of the structure which Einstein has reared. We must not on this ground condemn Einstein.

Such anticipations are as interesting to the philosopher as they are important to the historian of science. It is with mingled emotions of the philosopher and the historian that we reprint, in the SCIENTIFIC AMERICAN MONTHLY for July, an article which originally appeared in the SCIENTIFIC AMERICAN SUPPLEMENT of May 11, 1889. It is signed by a name which today is familiar to us all, but which thirty-two years ago must have been a new one to most of those who saw it in our columns—Hudson Maxim.

When we go back to this article, bearing with us the knowledge and the general scientific background of today, our reactions are curiously mixed. Mr. Maxim used the expression "ultimate atom." Ultimate particle would have been more in keeping with modern usage. The twentieth-century mathematician who assumes things to be true because he can find nothing simpler in terms of which to prove them, and who deliberately chooses the things which it pleases him to assume, will quarrel with Mr. Maxim's statement of axioms on the ground of natural truth and obviousness. But he cannot deny the axioms themselves, nor, having granted these, can he quarrel with the conclusions.

In many of its fundamentals every reader will recognize that we have here an effort to state, so far as the mental horizon of 1889 would encompass it, the philosophical outline of Einstein's Special Theory. It is on this account, as well as because Mr. Maxim wishes it put before the present generation in black and white as a preliminary to something further which he has to say, that we reprint it in the MONTHLY for July.

Naval and Merchant Marine

Lighting of Ships at Sea.—Several interesting problems were discussed at the last meeting of the Illuminating Engineering Society. Among the special problems discussed was that of lighting the charthouse and compass-dials. Concealed lighting is recommended, an approved method being the lighting of charts mounted between sheets of glass by diffused light transmitted from below. Some members favored the use of lights on deck if the sources of light could be screened.

One-third of American Crews Native.—A recent report of the Department of Commerce, giving a list of the nationalities of the crews of American merchant vessels, discloses the gratifying fact that nearly one-third of the crews of American ships are native-born. Thus, out of 25,264 officers, 16,803 are native-born, and 6,985 are naturalized citizens. Of 155,024 men, 50,966 are native-born and 10,898 are naturalized citizens. Of foreigners, the British account for 518 officers and 21,261 men; the Norwegians for 263 officers and 5,938 men; and 43 officers and 16,528 men are Spanish.

The Trials of the "Tennessee."—The battleship "Tennessee," our latest electrically-driven dreadnaught, has recently passed successfully through her final trials off Rockland. She bettered the Westinghouse Company's guarantees of steam consumption by about seven per cent. The maximum speed was 21.38 knots, and she was brought to rest from top speed in less than three minutes. The salvo tests, in which twelve 14-inch guns were fired at once, caused no injury to her electrical equipment. Going astern she developed 15 knots, and her turning radius, with all propellers operating and rudder hard over, was about 700 yards.

Rapid Work on City Piers.—It is announced that the first of the twelve piers which are being built at Staten Island will be ready for occupancy on August 6th. Murray Hulbert, Commissioner of Docks and Ferries, is to be congratulated upon the rapidity of the work. All of the piers will be ready by the end of the year. Seeing that the first pile was driven on May 5, 1920, this speeding up is in strong contrast to the dilatoriness which almost invariably distinguishes city construction. The piers are over 1,000 feet in length; ten of them have single-story and the other two double-deck pier sheds, and they have the advantage that there is a bay between the piers 300 feet in width.

Results of Naval Bombing Tests.—Without wishing to detract from the work of the naval airmen in sinking a German U-boat early in the first bombing test, it is our duty to warn the public against drawing exaggerated conclusions. The U-boat was stationary. It had no anti-aircraft guns, and it was therefore a passive object of attack. The result proves that a 163-pound bomb falling on the deck of an unoccupied and undefended U-boat will sink it. It does not prove that an airplane can sink a battleship; merely it shows that a bomb of this size will work some destruction on the upper decks. What a 500- or 1,000-pound bomb will do on a battleship will be proved in the tests later this month against the "Ostfriesland."

Strategical Value of Cape Cod Canal.—It has been recommended to Congress by Secretary of War Weeks that the Government purchase the Cape Cod Canal for $11,500,000. This is five million dollars less than was allowed by a Federal Court during condemnation proceedings instituted by the Government. While the canal has great commercial value as providing a shorter and more sheltered route from Long Island Sound to Boston, it also is of considerable strategic value as forming part of an inside sheltered route from Boston by way of the Sound, the Raritan Canal and other inland waters to the Chesapeake. In the event of war this system of waterways would enable destroyers and other vessels of moderate draft to be transferred without risk of attack.

American Maritime Policies.—In his address before the Eighth National Foreign Trade Convention, Mr. James A. Farrell made the following points: One, no sale at present of Government vessels to private owners; two, our steamships are well constructed and compare with the best abroad; three, the average cost approximates that of foreign ships; four, even with temporary improvements in freights it will take three years to absorb the world's idle tonnage; five, international agreement to stabilize rates and lay up tonnage might be useful; six, American traders and travelers should use American ships; seven, we should abandon the attempt to build up trade routes from every United States port and serve only ports where cargo is available; eight, Time-charter Shipping Board vessels with option of purchase; nine, operating costs must be reduced to equality with foreign costs; ten, shipping laws which impose a disadvantage estimated at 6% per cent on investment should be repealed.

Science

News from Graham Island.—It seems only yesterday that we chronicled the sailing of the Cope Expedition, but now we have received word that a landing has been made at Graham Island. Rich seal and penguin colonies have been found.

Nuisance Roots Prove Valuable.—The scrub palmetto root, for years regarded as probably the most worthless product of the soil of the Gulf States and a source of heavy expense when land is being cleared for planting, is worth something after all. Extensive experiments with a view to utilizing the fiber of the root for the manufacture of brushes have been successful.

Restless Plymouth Rock.—For the second time in four months, Plymouth Rock has been moved. On December 21, after the canopy over the rock was torn down the boulder was moved about fifty feet. Three guards have watched over it night and day since. To do away with these guards the rock was again moved and placed in a brick building. The windows have been barred and the door securely locked. Of course the end of the perambulations is not yet.

University Population.—At Columbia 700 student applicants were turned away last year and the experience of all colleges and universities seems to be the same. Technical education particularly has increased by leaps and bounds, for while in the period from 1890 to 1918 the general increase in university enrollment was 130 per cent, the engineering schools had increased eight times as much. The great difficulty is in securing competent instruction and enough of it.

Aviator Explores the Grand Canyon.—An army flier, Lieut. Pearson, has explored the Grand Canyon with a view to studying the air currents. His experiences are interesting. He says: "In spite of the fact that the upper part of the Grand Canyon is thirteen miles from rim to rim and the lower gorge is eight miles wide, I felt cramped for room when I was descending into the chasm. I seemed every moment to be flying right slap into some cliff."

Radio Congress.—The Radio Congress opened its sessions in Paris June 21. The purpose of the conference is to harmonize the radio rules of the world and formulate plans for bringing wireless into more general use through the encouragement of private enterprise under Government control. The American Government has sent a delegation of ten of its best military and civil experts, headed by Major Gen. George O. Squier, Chief of the Signal Service of the United States Army. Others in the party include Professors A. E. Kennelly of Harvard, J. H. Dellinger of the Bureau of Standards of the Department of Commerce, Major J. A. Maubourgne, for the United States Army; Admiral Magruder and Captain G. R. Evans, representing the American Navy, and Dr. Louis Cohen.

The Book of Tapa.—The interesting museum of the University of Pennsylvania is always adding something unique. They have just secured one of the few copies of what is known as "The Book of Tapa." In 1787 there was published in London an interesting and curious book styled a "Catalogue" and illustrated with samples cut from specimens of the *tapa* or bark cloth collected by Captain Cook and his companions during the great explorer's three voyages. The number of specimens of cloth varies in each known copy; this one has forty-three specimens or four more than in the printed list in the book. The work is dedicated to an unknown person, probably Warren Hastings, whose impeachment was pending when the dedication was written. The *Museum Journal* contains a number of colored plates from this very interesting book.

Mme. Curie Returns.—Filled with honors and weariness Mme. Curie sailed on June 25th on the "Olympic." Down in that holy of holies—the specie room—was carried her precious gram of radium. Special precautions had to be taken on account of the ship's instruments, for the compasses must not be disturbed in their functions. The Bureau of Standards carried out the shipping instructions. A beautiful mahogany case lined with lead and steel was provided. Although the box is not large, it weighs, with these linings, 130 pounds. Directly in the center of the box are several small compartments, formed of lead and surrounded by steel, each one of the right size to admit a small glass tube containing a portion of the radium salts—the form in which the metal is handled for shipment. The lid of the mahogany box is inlaid with a gold plate, handsomely marked with the following inscription: "Presented by the President of the United States on behalf of the women of America to Madame Marie Sklodowska Curie in recognition of her transcendent service to science and humanity in the discovery of radium. The White House, May 20, 1921."

Automobile

Farm Tractors Reduce Market for Large Engines.—With the increase in the use of farm tractors the market for large stationary farm engines—engines of 10, 15 and 20 horsepower—has declined materially. Formerly silo-filling for instance, required an engine of this size, but now the tractor engine usually serves the purpose. The market for small farm engines on the other hand, is not appreciably affected, as the farmer cannot afford to run the tractor half a mile or more every time he wants to do some corn-shelling or run the lighting plant.

The Closed Garage Door has brought more than one motorist to the ragged edge of profanity when returning home on a stormy night. Various means have been offered to enable him to open it without leaving his car, but most of these have been home-made affairs of doubtful utility. A device is now offered which consists of a plate inserted in the driveway in front of the door, connected with a release in such style that the passage of one wheel of the car over the plate automatically and immediately opens the door. Incidentally, in the absence of a car to run over this plate, the device acts as a trick lock which would puzzle a sneak thief very badly.

Valve-Steel Heat Treatment.—The proper heat-treatment for the valves of internal-combustion engines is given in an English house-organ as follows: 3½-per-cent nickel-steel should be normalized at 830—850 degrees centigrade. No further treatment is necessary. 25-per-cent nickel-steel should be normalized at 880—900 degrees centigrade. No further treatment is necessary. 13—18-per-cent tungsten valves should be heated to 950 degrees centigrade and cooled in still air, then reheated to 800 degrees centigrade and cooled in still air before machining. 13-per-cent chromium valves should be heated to 900 degrees centigrade and cooled in oil, then reheated to 700 degrees centigrade and cooled in still air before cooling in oil.

Paris Tries Six-Wheel Bus.—Experiments are now being carried out in Paris with a six-wheel single deck omnibus steering through the front and the rear pair of wheels, and driving through the center pair. The advantage of the new type is that an increased wheel base and additional carrying capacity are obtained with the same turning radius as for the normal two axle machine. The experimental buses are being run on the Madeleine-Bastille route, which comprises the most crowded boulevards of the city. No changes have been made in the engine, which is a four-cylinder type placed under the driver's feet; the live axle is also practically the same, and the third axle is a duplicate of the front axle. Suspension is by means of three pairs of semi-elliptic springs.

Striking Plate for Doors.—An adjustable striking plate designed to replace the old non-adjustable plate or catch on automobile doors is now manufactured. The old-style catch is made with one or two non-adjustable steps and must be fitted very carefully to the jamb of the door, so that when the door is closed it is held firmly against the rubber bumpers. Any wear of the rubber bumpers, lock bolt or catch permits the door to vibrate or rattle. The Franzen adjustable striking plate can be fitted after it is in position on the jamb. Any wear which has a tendency to loosen the door and cause it to rattle can be compensated for by means of an accessible adjusting screw. By turning the screw to the left the second movable step of the striking plate is moved in. This adjustment again brings the door when closed into intimate contact with the bumper.

Improved Adjustable Yoke End.—With the ordinary yoked rod ends used in brake connections it is not as easy a matter to make an adjustment of the brakes as may seem to be the case. First the cotter pin has to be removed from the pin of the yoke end, then the yoke pin itself must be removed, the yoke end rotated one or more half turns on the end of the rod, the yoke pin replaced and the cotter pin reinserted. With a view to facilitating this operation an ingenious yoke end has been brought out. An intermediate piece between the yoke end proper and the rod is provided with ears or finger pieces so that it can be readily turned without the use of tools. This intermediate piece is in the form of a threaded collar which turns with comparative freedom in the hub of the yoke proper, but the tendency of vibration to work it out of adjustment is prevented by providing one head with a V-shaped projection which engages with a corresponding notch in the hub of the yoke under the pressure of a coiled spring. This adjustable yoke end takes the place of the adjustable yoke and turnbuckle. It is claimed to be easier to assemble, to adjust either by hand or wrench and to be less expensive than a separate yoke end and turnbuckle.

VOLUME
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The Limitations of Aerial Bombing

NAVAL officers point out that there have been appearing in the press with increasing frequency erroneous statements respecting the cost of battleships as compared with aircraft. It is also claimed that aerial bombs are more destructive than gun projectiles, because such bombs contain a larger percentage of explosive than armor-piercing shells of the same size. The statements most frequently made with respect to costs are that 1,000 airplanes can be constructed for the cost of one present-day battleship; that each plane can carry a bomb of sufficient power to sink a battleship; and that the airplane requires a personnel of only two or three men, whereas the battleship requires 800 or more.

In the first place present-day cost of battleships, due to lower prices, is less than $45,000,000; but granting the cost to be that sum, and that such a battleship could be used for the first line for a period of 15 years, and the second line for ten yaers, at an annual up-keep cost of $1,000,000, the cost of the battleship for 25 years would be $70,000,000, or $2,800,000 yearly. Granted that 1,000 planes can be built for $45,000,000—which, on account of the diversified types required by complete naval air force, seems hardly possible, inasmuch as planes of the larger type cost considerably more than $45,000 each, including their equipment—it should be borne in mind that the life of a plane in service is approximately two years. Hence, the entire cost of the planes must be again spent each succeeding two years, or 12½ times during the life of a battleship; and inasmuch as not less than 50 per cent on the average, of the first cost of a plane is required to keep it in commission for two years, the total cost of 1,000 planes for 25 years would be $843,750,000, or $33,748,000 per year, a sum sufficient to keep in commission 12 battleships of the present-day type.

Furthermore, in the matter of personnel, Naval officers do not agree with the printed statements. A battleship such as contemplated would have a crew of 1,500 officers and men instead of 800, while in the case of airplanes, for every man in the air there is required approximately 20 on the ground. On this basis, 12 battleships would require 18,000 officers and men, and 1,000 airplanes, on the basis of one man in the plane and 20 on the ground, would require 21,000 personnel. To be perfectly fair in the matter, it may be considered that the personnel of the two would about cancel each other in cost, inasmuch as highly skilled mechanics are required on battleships and aircraft alike. In the case of landing fields and hangars for 1,000 aircraft, we may also consider that the expense is canceled by docks and navy yards required for the repair of battleships. That brings the case down to a comparison of material cost, and, as above stated, 1,000 aircraft stretched over a period of 25 years, which is the extreme life of a battleship, would equal the cost of 12 such battleships.

Regarding the statement that aircraft could each carry a bomb sufficiently large to destroy a battleship, it is not believed that at the present day this can be done. Bombs have not been developed to such an extent that they are armor-piercing, and after landing on the deck of a ship their destructiveness would be local. The experiments on the U.S.S. "Indiana" with a large bomb filled with T.N.T. which was exploded on her deck, causing considerable damage to her old-style upper works, has been used as an illustration of what bombs can do, and statements have been made that if the bomb were destructive when laid on the deck, it would be much more so if dropped from an airplane. This is erroneous. The destructiveness of T.N.T., unconfined, has a certain potentiality which is not increased by the mere dropping of the T.N.T. from a height. *It is necessary for the projectile to pierce the armor of the ship and explode inside of her hull.* This cannot be done by thin-walled aerial bombs subject only to the impulse of gravity. There must be acceleration beyond the force of gravity to cause the shell to pierce armor and the shell must be of the armor-piercing variety; consequently, the weight of the shell wall reduces the amount of T.N.T. which it may contain, reducing the destructiveness of the bomb.

It is believed that the actual facts should be given the public. Erroneous comparisons which only bring out one side of the argument do not help the cause of aeronautics but do more harm than good.

The Lampert Bill

THE United States Congress passes, each year, appropriation bills designed to give the various branches of the Government funds for the year's operations. In part these appropriations are a matter of negotiation between the Bureau in question and the Committee of the House of Representatives involved. In equal part they have their basis in statutory provision as to how many men may be employed and at what salaries.

Present salaries in the Patent Office date back to 1848, at which time the patent examiner got the salary of a Federal District Judge. Today the Judge gets $6,000; the examiners have had a single increase of 10 per cent, and a $240 war bonus; they now get considerably less than half the pay of the judges with whom they were once on an equal footing. If comparison of qualifications is to be made, the requirements of the Patent Office are by all means harder to meet. And as for professional dignity, patent examination is in many respects juridical work, and should be compensated as such.

Turning from the question of salaries, we find that the Patent Office is seriously under-manned. Not alone has patent business been increasing by leaps and bounds until it is larger than ever before; the older and more experienced examiners have resigned in large numbers to enter commercial employment or private practice, and it takes two years of continual attention from his superiors to render a newly appointed examiner really competent. This explains why the Patent Office is 46,000 cases behind its schedule, so that if you file an application for a patent today you must wait seven months to get the preliminary report telling what the examiner thinks of it.

The Committee on Patents of the House of Representatives is picked on geographical and political grounds. If it is desired to have a Republican from Maryland and a Democrat from Kansas on this committee, on they go regardless of qualifications to deal with patent business. When a new Congress convenes, the best part of the new committee's time for months is spent in educating its new members—and sometimes its old members—as to what and why is a patent. The hearings of this committee always bring forward some absurd questions from its members, showing fundamental misunderstanding of the entire patent system.

We shall not argue these matters here; we have nothing to add to what we have said in the past. We shall only state that the Lampert Bill, which had a deal of attention from the Patents Committee of the old Congress, is up again in the new one. It provides proper salaries and an adequate staff for the Patent Office. Last time it was talked to death as much by its friends as by its enemies. There is no reason in the world why it should fail this time; and, in fact, it has excellent prospects of passing. When we find that the total payroll of the Patent Office, in the event of its unamended passage, will be but $1,951,840, it is clear that at least the wild cry of "economy" cannot be raised against it. In justice to the inventors and the manufacturers of America as well as to the Patent Office staff, it should be passed.

Relativity in 1889

THE ancients had a pretty myth about Minerva, the goddess of wisdom, whom they stated to have sprung, full-grown and full-panoplied, from the head of Jove. There is more in this legend than appears on the surface. Divine wisdom, perfect and boundless, if we conceive it ever to have had beginning at all, must thus have come into full being. We today should prefer to think of it as without beginning, as having always been, but that may be let pass. The ancient philosophers, at the period when they were still engaged in the personification of their ideas, had without exception failed to grasp the concept of infinite reaches of time—they still felt obliged to account for the beginning and the ending of things.

Human wisdom, unlike Minerva, never springs full-grown into being, but arrives at a given point, if we may mix our metaphors, only by a long and arduous process of toiling up the slopes. In the myth of Minerva the Greeks had in mind this essential distinction between the wisdom of the gods and that of the finite human mind. No single item of human knowledge, no single human doctrine, ever was formulated out of nothing in a single mind. Every such item is the result of slow growth and accretion, and in its final form contains the contribution of many minds. Ultimate formulation is often the work of a single intellect, but this intellect draws its material from the entire past history of the race. The historian of human thought finds it an absorbing business to pursue some great idea back through its ultimate sources. And always when we conduct this search we are amazed by the degree to which the work of the man who is recognized as the originator consists merely in restating in better form, and in a single place, things which have been said before in fragmentary fashion.

The apostles of Einstein, for instance, have realized well that in many respects this relativity of which we are all talking is but another instance of old wine in new bottles. The very phrase "classical relativity" with which so many of them introduce their subject indicates that its fundamentals are by no means new. It is the interpretation of the theory and its unique mathematical formulation that are Einstein's. Nevertheless we are inclined to regard as novel some of its more startling philosophical aspects. Some of them indeed are novel; the General Theory we believe is so; and even in the Special Theory, the assumption that light displays the same velocity to all observers however conditioned could not have been thinkable until twentieth-century physics had given a background of experiment and theory leading to the suggestion. But the very charges of plagiarism brought against Einstein, while absurd in principle, indicate that he has been building with old material to a greater extent than may have been realized. This, we reiterate, is the very nature of things. We must admire those who have supplied the material, who have anticipated parts of the structure which Einstein has reared. We must not on this ground condemn Einstein.

Such anticipations are as interesting to the philosopher as they are important to the historian of science. It is with mingled emotions of the philosopher and the historian that we reprint, in the SCIENTIFIC AMERICAN MONTHLY for July, an article which originally appeared in the SCIENTIFIC AMERICAN SUPPLEMENT of May 11, 1889. It is signed by a name which today is familiar to us all, but which thirty-two years ago must have been a new one to most of those who saw it in our columns—Hudson Maxim.

When we go back to this article, bearing with us the knowledge and the general scientific background of today, our reactions are curiously mixed. Mr. Maxim used the expression "ultimate atom." Ultimate particle would have been more in keeping with modern usage. The twentieth-century mathematician who assumes things to be true because he can find nothing simpler in terms of which to prove them, and who deliberately chooses the things which it pleases him to assume, will quarrel with Mr. Maxim's statement of axioms on the ground of natural truth and obviousness. But he cannot deny the axioms themselves, nor, having granted these, can he quarrel with the conclusions.

In many of its fundamentals every reader will recognize that we have here an effort to state, so far as the mental horizon of 1889 would encompass it, the philosophical outline of Einstein's Special Theory. It is on this account, as well as because Mr. Maxim wishes it put before the present generation in black and white as a preliminary to something further which he has to say, that we reprint it in the MONTHLY for July.

Naval and Merchant Marine

Lighting of Ships at Sea.—Several interesting problems were discussed at the last meeting of the Illuminating Engineering Society. Among the special problems discussed was that of lighting the charthouse and compass-dials. Concealed lighting is recommended, an approved method being the lighting of charts mounted between sheets of glass by diffused light transmitted from below. Some members favored the use of lights on deck if the sources of light could be screened.

One-third of American Crews Native.—A recent report of the Department of Commerce, giving a list of the nationalities of the crews of American merchant vessels, discloses the gratifying fact that nearly one-third of the crews of American ships are native-born. Thus, out of 25,264 officers, 16,803 are native-born, and 6,985 are naturalized citizens. Of 155,024 men, 50,966 are native-born and 10,898 are naturalized citizens. Of foreigners, the British account for 518 officers and 21,261 men; the Norwegians for 263 officers and 5,938 men; and 43 officers and 16,528 men are Spanish.

The Trials of the "Tennessee."—The battleship "Tennessee," our latest electrically-driven dreadnaught, has recently passed successfully through her final trials off Rockland. She bettered the Westinghouse Company's guarantees of steam consumption by about seven per cent. The maximum speed was 21.38 knots, and she was brought to rest from top speed in less than three minutes. The salvo tests, in which twelve 14-inch guns were fired at once, caused no injury to her electrical equipment. Going astern she developed 15 knots, and her turning radius, with all propellers operating and rudder hard over, was about 700 yards.

Rapid Work on City Piers.—It is announced that the first of the twelve piers which are being built at Staten Island will be ready for occupancy on August 6th. Murray Hulbert, Commissioner of Docks and Ferries, is to be congratulated upon the rapidity of the work. All of the piers will be ready by the end of the year. Seeing that the first pile was driven on May 5, 1920, this speeding up is in strong contrast to the dilatoriness which almost invariably distinguishes city construction. The piers are over 1,000 feet in length; ten of them have single-story and the other two double-deck pier sheds, and they have the advantage that there is a bay between the piers 300 feet in width.

Results of Naval Bombing Tests.—Without wishing to detract from the work of the naval airmen in sinking a German U-boat early in the first bombing test, it is our duty to warn the public against drawing exaggerated conclusions. The U-boat was stationary. It had no anti-aircraft guns, and it was therefore a passive object of attack. The result proves that a 163-pound bomb falling on the deck of an unoccupied and undefended U-boat will sink it. It does not prove that an airplane can sink a battleship; merely it shows that a bomb of this size will work some destruction on the upper decks. What a 500- or 1,000-pound bomb will do on a battleship will be proved in the tests later this month against the "Ostfriesland."

Strategical Value of Cape Cod Canal.—It has been recommended to Congress by Secretary of War Weeks that the Government purchase the Cape Cod Canal for $11,500,000. This is five million dollars less than was allowed by a Federal Court during condemnation proceedings instituted by the Government. While the canal has great commercial value as providing a shorter and more sheltered route from Long Island Sound to Boston, it also is of considerable strategic value as forming part of an inside sheltered route from Boston by way of the Sound, the Raritan Canal and other inland waters to the Chesapeake. In the event of war this system of waterways would enable destroyers and other vessels of moderate draft to be transferred without risk of attack.

American Maritime Policies.—In his address before the Eighth National Foreign Trade Convention, Mr. James A. Farrell made the following points: One, no sale at present of Government vessels to private owners; two, our steamships are well constructed and compare with the best abroad; three, the average cost approximates that of foreign ships; four, even with temporary improvements in freights it will take three years to absorb the world's idle tonnage; five, international agreement to stabilize rates and lay up tonnage might be useful; six, American traders and travelers should use American ships; seven, we should abandon the attempt to build up trade routes from every United States port and serve only ports where cargo is available; eight, Time-charter Shipping Board vessels with option of purchase; nine, operating costs must be reduced to equality with foreign costs; ten, shipping laws which impose a disadvantage estimated at five per cent on investment should be repealed.

Science

News from Graham Island.—It seems only yesterday that we chronicled the sailing of the Cope Expedition, but now we have received word that a landing has been made at Graham Island. Rich seal and penguin colonies have been found.

Nuisance Roots Prove Valuable.—The scrub palmetto root, for years regarded as probably the most worthless product of the soil of the Gulf States and a source of heavy expense when land is being cleared for planting, is worth something after all. Extensive experiments with a view to utilizing the fiber of the root for the manufacture of brushes have been successful.

Restless Plymouth Rock.—For the second time in four months, Plymouth Rock has been moved. On December 21, after the canopy over the rock was torn down the boulder was moved about fifty feet. Three guards have watched over it night and day since. To do away with these guards the rock was again moved and placed in a brick building. The windows have been barred and the door securely locked. Of course the end of the perambulations is not yet.

University Population.—At Columbia 700 student applicants were turned away last year and the experience of all colleges and universities seems to be the same. Technical education particularly has increased by leaps and bounds, for while in the period from 1890 to 1918 the general increase in university enrollment was 139 per cent, the engineering schools had increased eight times as much. The great difficulty is in securing competent instruction and enough of it.

Aviator Explores the Grand Canyon.—An army flier, Lieut. Pearson, has explored the Grand Canyon with a view to studying the air currents. His experiences are interesting. He says: "In spite of the fact that the upper part of the Grand Canyon is thirteen miles from rim to rim and the lower gorge is eight miles wide, I felt cramped for room when I was descending into the chasm. I seemed every moment to be flying right slap into some cliff."

Radio Congress.—The Radio Congress opened its sessions in Paris June 21. The purpose of the conference is to harmonize the radio rules of the world and formulate plans for bringing wireless into more general use through the encouragement of private enterprise under Government control. The American Government has sent a delegation of ten of its best military and civil experts, headed by Major Gen. George O. Squier, Chief of the Signal Service of the United States Army. Others in the party include Professors A. E. Kennelly of Harvard, J. H. Dellinger of the Bureau of Standards of the Department of Commerce, Major J. A. Maubourgne, for the United States Army; Admiral Magruder and Captain G. R. Evans, representing the American Navy, and Dr. Louis Cohen.

The Book of Tapa.—The interesting museum of the University of Pennsylvania is always adding something unique. They have just secured one of the few copies of what is known as "The Book of Tapa." In 1787 there was published in London an interesting and curious book styled a "Catalogue" and illustrated with samples cut from specimens of the *tapa* or bark cloth collected by Captain Cook and his companions during the great explorer's three voyages. The number of specimens of cloth varies in each known copy; this one has forty-three specimens or four more than in the printed list in the book. The work is dedicated to an unknown person, probably Warren Hastings, whose impeachment was pending when the dedication was written. The *Museum Journal* contains a number of colored plates from this very interesting book.

Mme. Curie Returns.—Filled with honors and weariness Mme. Curie sailed on June 25th on the "Olympic." Down in that holy of holies—the specie room—was carried her precious gram of radium. Special precautions had to be taken on account of the ship's instruments, for the compasses must not be disturbed in their functions. The Bureau of Standards carried out the shipping instructions. A beautiful mahogany case lined with lead and steel was provided. Although the box is not large, it weighs, with these linings, 130 pounds. Directly in the center of the box are several small compartments, formed of lead and surrounded by steel, each one of the right size to admit a small glass tube containing a portion of the radium salts—the form in which the metal is handled for shipment. The lid of the mahogany box is inlaid with a gold plate, handsomely marked with the following inscription: "Presented by the President of the United States on behalf of the women of America to Madame Marie Sklodowska Curie in recognition of her transcendent service to science and humanity in the discovery of radium. The White House, May 20, 1921."

Automobile

Farm Tractors Reduce Market for Large Engines.—With the increase in the use of farm tractors the market for large stationary farm engines—engines of 10, 15 and 20 horsepower—has declined materially. Formerly silo-filling for instance, required an engine of this size, but now the tractor engine usually serves the purpose. The market for small farm engines on the other hand, is not appreciably affected, as the farmer cannot afford to run the tractor half a mile or more every time he wants to do some corn-shelling or run the lighting plant.

The Closed Garage Door has brought more than one motorist to the ragged edge of profanity when returning home on a stormy night. Various means have been offered to enable him to open it without leaving his car, but most of these have been home-made affairs of doubtful utility. A device is now offered which consists of a plate inserted in the driveway in front of the door, connected with a release in such style that the passage of one wheel of the car over the plate automatically and immediately opens the door. Incidentally, in the absence of a car to run over this plate, the device acts as a trick lock which would puzzle a sneak thief very badly.

Valve-Steel Heat Treatment.—The proper heat-treatment for the valves of internal-combustion engines is given in an English house-organ as follows: 3½-per-cent nickel-steel should be normalized at 830—850 degrees centigrade. No further treatment is necessary. 25-per-cent nickel-steel should be normalized at 880—900 degrees centigrade. No further treatment is necessary. 13—18-per-cent tungsten valves should be heated to 950 degrees centigrade and cooled in still air, then reheated to 800 degrees centigrade and cooled in still air before machining. 13-per-cent chromium valves should be heated to 900 degrees centigrade and cooled in oil, then reheated to 700 degrees centigrade and cooled in still air before cooling in oil.

Paris Tries Six-Wheel Bus.—Experiments are now being carried out in Paris with a six-wheel single deck omnibus steering through the front and the rear pair of wheels, and driving through the center pair. The advantage of the new type is that an increased wheel base and additional carrying capacity are obtained with the same turning radius as for the normal two axle machine. The experimental buses are being run on the Madeleine-Bastille route, which comprises the most crowded boulevards of the city. No changes have been made in the engine, which is a four-cylinder type placed under the driver's feet; the live axle is also practically the same, and the third axle is a duplicate of the front axle. Suspension is by means of three pairs of semi-elliptic springs.

Striking Plate for Doors.—An adjustable striking plate designed to replace the old non-adjustable plate or catch on automobile doors is now manufactured. The old-style catch is made with one or two non-adjustable steps and must be fitted very carefully to the jamb of the door, so that when the door is closed it is held firmly against the rubber bumpers. Any wear of the rubber bumpers, lock bolt or catch permits the door to vibrate or rattle. The Franzen adjustable striking plate can be fitted after it is in position on the jamb. Any wear which has a tendency to loosen the door and cause it to rattle can be compensated for by means of an accessible adjusting screw. By turning the screw to the left the second movable step of the striking plate is moved in. This adjustment again brings the door when closed into intimate contact with the bumper.

Improved Adjustable Yoke End.—With the ordinary yoked rod ends used in brake connections it is not as easy a matter to make an adjustment of the brakes as may seem to be the case. First the cotter pin has to be removed from the pin of the yoke end, then the yoke pin itself must be removed, the yoke end rotated one or more half turns on the end of the rod, the yoke pin replaced and the cotter pin reinserted. With a view to facilitating this operation an ingenious yoke end has been brought out. An intermediate piece between the yoke end proper and the rod is provided with ears or finger pieces so that it can be readily turned without the use of tools. This intermediate piece is in the form of a threaded collar which turns with comparative freedom in the hub of the yoke proper, but the tendency of vibration to work it out of adjustment is prevented by providing one head with a V-shaped projection which engages with a corresponding notch in the hub of the yoke under the pressure of a coiled spring. This adjustable yoke end takes the place of the adjustable yoke and turnbuckle. It is claimed to be easier to assemble, to adjust either by hand or wrench and to be less expensive than a separate yoke end and turnbuckle.

Is It To Be Bomb or Battleship?

Elaborate Series of Tests to Determine the Effectiveness of Aircraft Against Warships

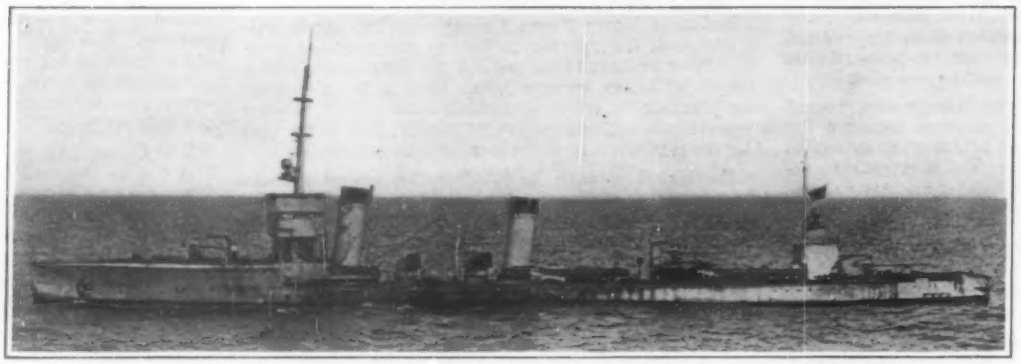
NAVAL history shows that whenever a novel and startling weapon of attack is developed, it is pretty sure to be credited with destructive power far beyond its capacity. So it was with the torpedo, the torpedo boat, the destroyer, the "dynamite" gun and the submarine. Today in the van of this procession of cheap, quick kill-alls, proud of past accomplishment and boastful of its future conquests, is the bomb-dropping airplane.

The search for a cheap substitute for the major weapons of war is persistent, and it is perfectly natural that the smallest early successes of each should be magnified in the public mind, and that prediction should run riot as to their future performance—for is not the wish ever father to the thought?

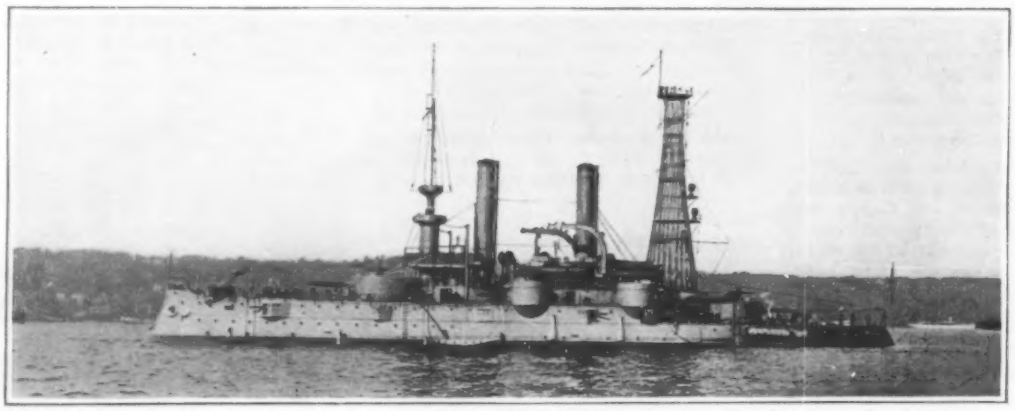
This is all quite understandable in the layman; but that the technically-instructed officers should mount, as they so often do, into the doubtful atmosphere of prophecy, is something to give us pause. Anyone who has read the diatribes of the late Lord Fisher and of Sir Percy Scott against the battleship supplemented as it has recently been, by the testimony of our own General Mitchell and Admiral Fullom, must have wondered what had become of that fine old sense of proportion which we used to believe was a distinguishing characteristic of the men who passed through our naval and military colleges. However, the Army and Navy are now at the job of settling the question as to whether the capital ship of the future will be one that floats upon the water or one that sails through the air. We have been told that the battleship is doomed, and that the aircraft has done it. The Navy is not disturbed, being perfectly satisfied, not only that the battleship has not been rendered obsolete by the airplane, but that the big ship that floats upon the sea and carries the big gun was never more alive and more efficient than today, and never gave such promise of holding, for many years to come, its commanding position. The tests which are now under way will come pretty near to settling this much disputed question.

The first of the tests was the sinking of one of the captured German submarines. In this, as in the other experiments, the Army and Navy fliers cooperated.

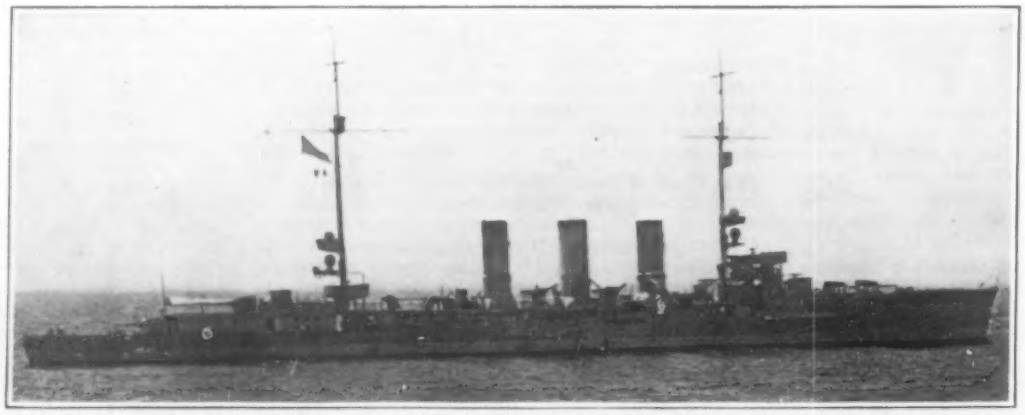
The next step in the operations will be the searching by aircraft for the "Iowa" in a definite area extending from the entrance to Delaware Bay to Cape Hatteras, and with a radius of one hundred miles off shore. She will be operated under radio control from the "Ohio," several miles distant, and after the aircraft locate her she will be bombed by dummy bombs, in order to determine the extent of the ability of aircraft to register hits on a moving target. No explosives are to be dropped on the "Iowa," as she is to be used later as a moving target for the fleet's big guns.



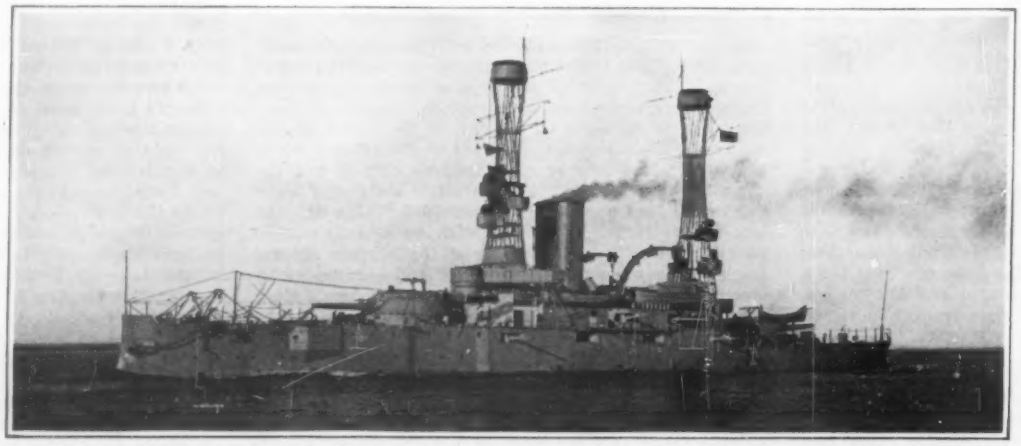
Ex-German destroyer which formed the object of bomb attack by Army and Navy aviators. This is one of the surrendered German ships



Battleship "Iowa", operated by radio control from the "Ohio", several miles distant, to be attacked with dummy bombs



Ex-German cruiser "Frankfort" will first be bombed by aircraft. If not destroyed she will be sunk by big-gun fire



Battleship "Alabama," turned over to the Army, who will use her, in conjunction with the Navy, in bombing tests

Next will come the bombing tests, with one of the ex-German destroyers as the target. This vessel will be attacked, and, if practicable, sunk by aircraft using 250-pound bombs. The other destroyers will be targets for the guns of our destroyers, as were two of the submarines.

After that will take place the bombing by the Navy and Army aircraft of the ex-German cruiser "Frankfurt," and ex-German battleship "Ostfriesland." All of the ex-German ships are eventually to be sunk, if not by bombs or gunfire, then by depth charges. They are being destroyed in conformity with the international agreement by which they were obtained.

The tests, which will be continued on through July, are for the purpose of determining the effect of gunfire and aerial bombing on the structure and material of the various vessels to be attacked, as well as for tactical search exercises and tests to determine the *accuracy* of bombing.

Tests will be made in a series of progressive steps. The vessel will be examined by experts after each attack is completed, and the tests will be conducted slowly so that the maximum knowledge of the effect of the explosives may be determined.

An interesting feature will be the test of communications, from aircraft to shore stations, and from aircraft to aircraft, working against radio interference, in securing a concentration of the bombing fleet over the enemy after the scouts have picked up the objective.

These bombing tests, according to Captain Johnson, Commander of the Atlantic Fleet Air Force, are merely a part of the day's work in the routine of the navy. They will be of no value unless they are conducted along scientific lines.

The Navy must know what effect the bombs will have and the number of hits which can be made by aircraft. It is unnecessary to drop 2,000-pound bombs on a destroyer to sink her if a 250-pound bomb will do the

work of destruction just as completely.

Consequently, the air force will use small bombs on the destroyers and submarines, and will determine, after hits are made, how much damage is done and the lessons to be learned from the experiment. It will be the same in the case of the "Frankfurt" and "Ostfriesland." First, hits will be made by bombs of moderate size, the effects being registered after each hit.

Then will follow attacks on the two ships, using larger bombs up to the largest, of 1,000 and 2,000 pounds, each time inspecting the ship to determine the damage done and the efficiency of the bombs themselves. The mere spectacular bombardment of the ships by a large number of bombs would serve no useful purpose; but carefully inspected results will teach the Navy certain points, not entirely known, respecting the efficiency of bombs and of the present methods of armor protection on the upper decks of large ships.

From the foregoing, then, it will be evident that the objects of these elaborate operations are to ascertain:

First, the ability of aircraft to locate vessels operating in the Coastal Zone, and to concentrate on such vessels sufficient bombing airplanes to make an effective attack.

Second, the probability of hitting, with bombs from airplanes, a vessel under way and capable of maneuvering, but incapable of anti-aircraft defense.

Third, the damage to vessels of comparatively recent design which will result from hits with bombs of various types and weights. The vessels to be attacked by bombing are of the battleship, light cruiser, destroyer and submarine types.

Fourth, by these experiments carried out at sea in deep water, to demonstrate the effect of an airplane bombardment of naval craft more effectively than may be done by experiments conducted with the vessels at anchor in shallow water.

Fifth, it should be noted that the experiments outlined by the Navy Department do not contemplate experiments in the use of machine guns against personnel in exposed positions nor the effect of gas, incendiary and smoke bombs.

Lastly, to obtain data upon which to formulate the proper tactics to be used in attacking naval vessels by aircraft.

The first of the tests, on June 21st, resulted in the sinking of the German submarine "V-117" by a 163-pound bomb dropped from a height of 1,100 feet. Six minutes after the detonation the submarine disappeared.

In actual warfare an attack against a ship armed with anti-aircraft guns would have to be made at an elevation of several thousand feet.

Armstrong Radio Patent Sustained

As a result of litigation extending over a period of years, the Armstrong radio "feedback" patent has been held valid by Judge Mayer. This patent covers what is probably the most important circuit arrangement in use in modern radio. It made possible trans-oceanic communication and has contributed much to the art of radio telephone communication.

The feedback circuit magnifies the signals received by wireless instruments thousands of times so that signals previously inaudible are now easily readable, and it further permits of very great selectivity, making possible reliable communication between two stations regardless of atmospheric conditions and of the transmission of messages by other stations.

Judge Mayer, in his opinion, says:

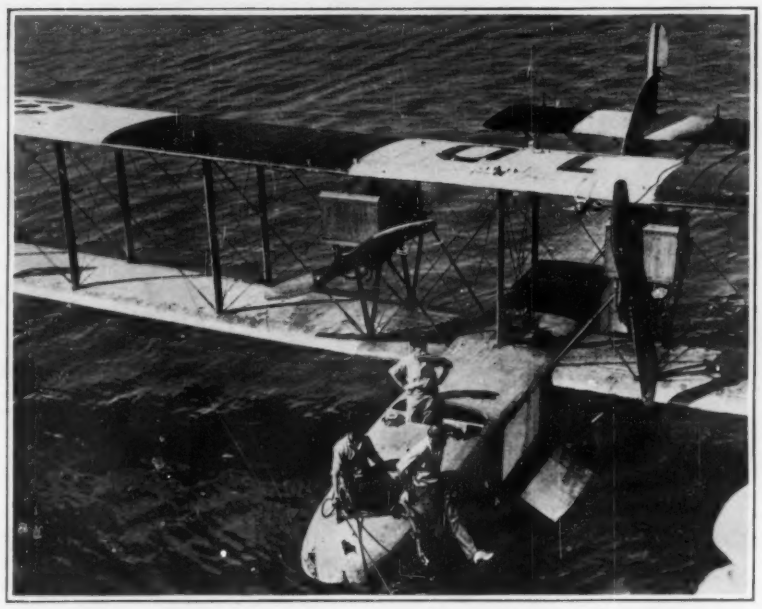
"This case is another contribution to the romance which has so often characterized the history of forward inventions. As a boy of 15, Armstrong became interested in radio and erected a radio station at his home. In the spring of 1912 he began a close study of the fundamental action of the audion and read all the literature on the subject. Sometime during this period he connected a condenser across the telephone of a simple audion receiving system and noticed that on some bulbs an increase in signal strength would result. It is important, at this point, to realize that Armstrong is a remarkably clear thinker. His achievement was not the result of an accident, but the consummation of a thoughtful and imaginative mind. Step by step he proceeded with the study and experiment. He was obtaining what seemed to him remarkable results, and in December, 1912, he had succeeded in inmproving the sensitiveness of the audion by means of a new connection.

The merit of the invention was soon recognized, and the very apparatus of which Armstrong made the invention was subsequently utilized commercially at Sayville, Long Island, shortly after the outbreak of the war in 1914, to overcome difficulties in the reception of signals from Nauen, Germany."

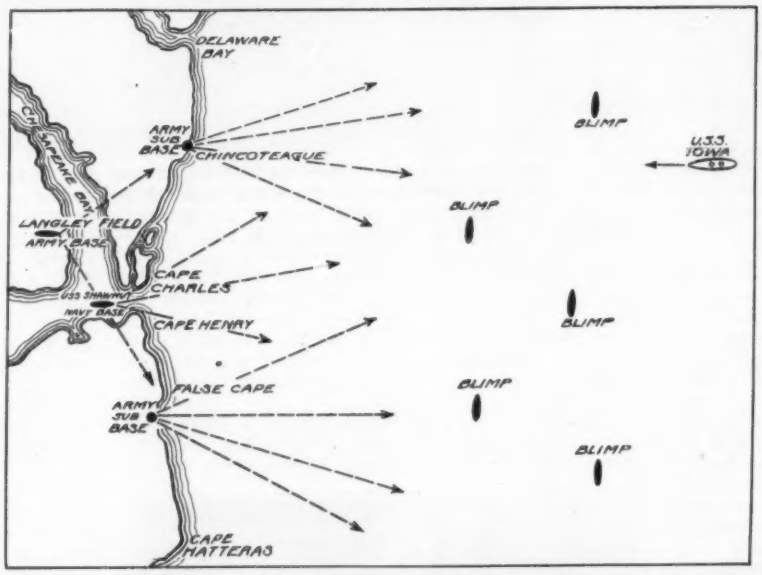
The invention, which by that time had become widely known, was used by the Signal Corps of all the armies in the field for receiving radio messages under the difficult conditions of warfare. The commercial value of the invention was appreciated at an early date and licenses were taken out by several companies during the years 1914 and 1916.

All radio amateurs are familiar with the circuit. It permits them to receive on a simple small antenna the radio signals transmitted from great distances. Thus it is possible for an amateur in and about New York with his antenna located on his apartment house and using the Armstrong feedback circuit to hear messages from Nauen, Honolulu, Darien, Norway, Philippine Islands, Lyons, and the great Lafayette Station installed by the Americans during the war at Bordeaux, France. It is also depended upon in the delicate work of direction finding which requires receiving instruments of the utmost delicacy. It was used on the NC Navy planes which crossed the Atlantic.

The principal defenses urged by the defendants were prior invention by De-Forest and that Armstrong's invention was of a very limited character. Judge Mayer held that Armstrong was the first inventor and that the invention was of a very broad character covering any feedback arrangement.

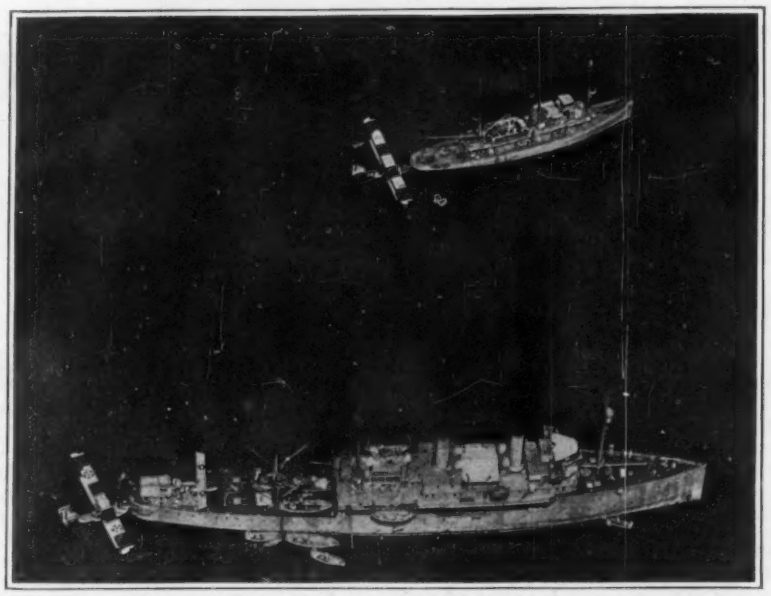


Close-up view of F-5-L being refueled from the mother ship "Shawmut", after an 1800-mile trip around the Caribbean



The plans for the bombing of the "Iowa", as she made a hostile approach to the American coast, so drawn up as to simulate, as far as possible, the defensive methods which would be used in actual war. In the outer zone, 50 to 100 miles off shore, a scouting squadron of blimps was stationed to discover the enemy and signal her position to the shore stations. Upon notification of her position and course, the aircraft concentrated for a sustained attack. Dummy bombs were used, the Navy Department wishing to reserve the ship as a target for big-gun fire at long range

Disposition of aircraft as "Iowa" approaches coast



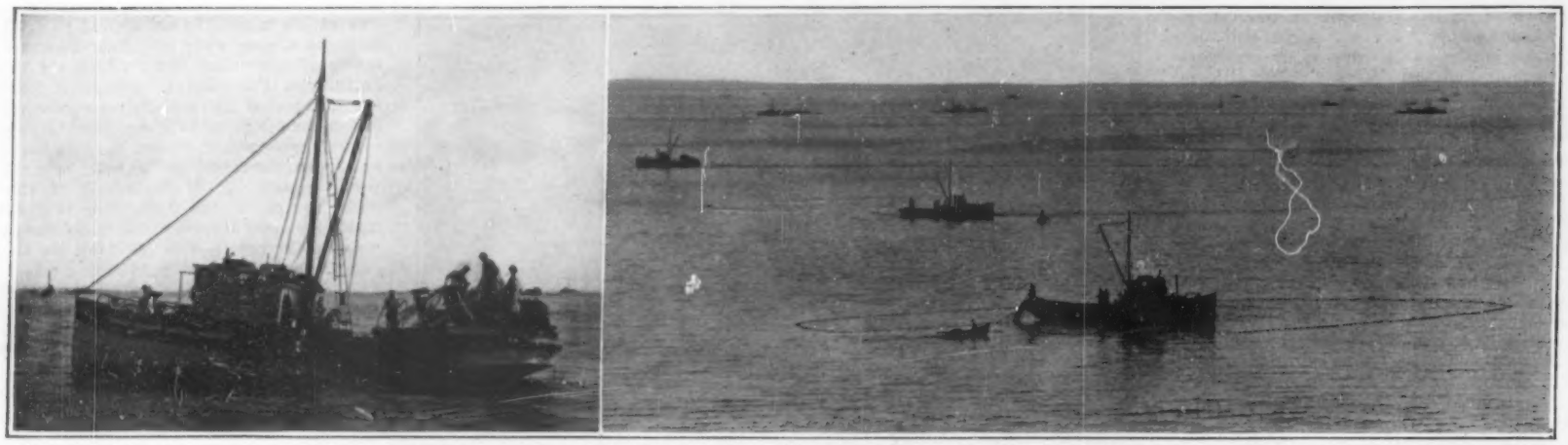
Two planes lying astern of their mother ships, from which supplies of fuel are being piped aboard

A Natural Potato Trade-Mark

An example of a curious natural trade-mark is found in the Red River district of Minnesota. This section is famous for its Early Ohio potatoes. Early Ohios do better here than anywhere else. Potato growers in the Middle West have learned that seed potatoes of this variety, originating in the Red River district, produce big crops and excellent quality. They have learned to determine the genuineness or otherwise of Early Ohio stock claimed to be Red River by looking for certain black spots on the tubers.

These black spots, the popular supposition goes, are a result of the rich black soil in which Red River Ohios are grown. Seed potato buyers are well aware that Early Ohios grown in sandier soil may be brighter, cleaner, even better looking, but it matters not. They do not carry the black spot's trade-mark of the Red River product, and are rejected.

The potato trade says that the Red River natural trade-mark will be missing from much of the 1920 crop, and buyers will be in something of a quandary, because of particularly favorable cultural conditions last season. Conditions have not been propitious for the development of the black disease spots. A trade-marking agency has broken down.



Left: Completing the "purse". The fish are gathered in a pocket of the net beside the boat. *Right:* Purse seiners at work on the Puget Sound salmon banks. A school of fish is being encircled by the fishermen's net in the foreground

Two stages in the catching of the sockeye salmon by means of the purse seine

Saving the Sockeye

An International Reclamation Project That Remains To Be Settled

By Robert A. Campbell

THE sockeye salmon, one of the choicest of North American food fish, is facing extinction. Its vast breeding grounds in the Fraser River system of British Columbia, are becoming sterile. Since, following in the "finsteps" of their ancestors, the sockeye seek these spawning grounds after passing through American waters which swarm with fishermen and their appliances, the restoration of the industry to its former magnitude has become an international problem.

Twenty-five years ago the annual sockeye run was one of the most remarkable sights in the Puget Sound country. In the fall of the year every river and small stream which mingled its fresh water with the brackish tides from the sea was alive with salmon. Millions upon millions of them, rubbing their sides together, wedged solidly from bank to bank, slowly working their way up stream. Farmers of the early days drove their wagons down to the water's edge and, pitchfork in hand, loaded tons of them for use in fertilizing their fields for the next season's crop. Late in the fall after the salmon had spawned, and before the floods had flushed the streams, the enormous quantities of dead fish strewn along the gravel bars sent up an odor which could be detected for miles around.

The summer of 1913 saw flood tide in the sockeye industry. That year the combined American and Canadian pack was 2,401,388 cases. In 1917 the pack fell to the alarming figure of 559,702 cases. During the season of 1920 the fishing business was but a pale shadow of its former self. The Pacific American fisheries, the largest concern on Puget Sound, reconstructed but six of its 15 traps. But 18 purse seiners were operating as against over 150 the year before. Formerly some 38 canneries were operating in Puget Sound waters with considerable seasonable regularity. In 1920 but six of them turned a wheel, and these were run on a short shift. Three canneries on Lummi Island, representing an investment of more than a million dollars, were idle all season.

When the irresistible instinct to go back to his fresh water birth place and spawn takes possession of the sockeye in his fourth year, he appears in great schools at the entrance to the Strait of Juan de Fuca. Here his battle against civilization and for reproduction sets in, for off Cape Flattery the purse seiners, tossing in their small boats, lie in wait. The shoals of fish head into the choppy strait, running the gauntlet of these small boats, until further progress is slightly barred by the San Juan Island group, thus forming the famous salmon banks.

Filtering through the narrow channels which separate these islands, the fish enter the Gulf of Georgia. Now a multitude of stationary traps lie before them, placed across their accustomed route of travel, while a still greater number of purse seiners sweep the adjacent waters.

If successful in avoiding the traps and seines still another barrier confronts the sockeye. He emerges from the Gulf and drives for the mouth of the Fraser River only to find a string of gill nets across his path. Stevenson, British Columbia, is the headquarters of the gill-net fishermen. Where the fish formerly had a stretch of water at times 35 miles wide in which to elude capture, he now finds himself in a narrow river.

Various means have been adopted to snare the sockeye. A purse seine is just what the name implies. This is the small-man method as it does not require great capital. The purse seine is a net, often 1,800 feet long, which is held perpendicularly in the water by weights at the bottom and corks which float on the surface. When not in use it is neatly arranged in folds at the stern of the boat, which carries a crew of eight men. When a school of fish is encountered, one end of the net is thrown out, a parachute contrivance catches the water so that it will not follow the boat, and the latter makes a circle, paying out the web as it goes. When the circle is complete the end first thrown out is picked up and the whole thing puckered into a bag or "purse."

There is a radical difference between a purse seine and a "trap." The former goes after the fish while the latter waits for them to come. In the infant days of the industry favorable trap locations—that is, shallow water near shore where the fish run in great numbers each year—were sold for snug fortunes.

A carpet of sockeye salmon on the cannery floor

A "trap" is made of piles, upon which common chicken wire is hung, and there you have it—a fish fence. It is built on the principle of a funnel, although shapes vary considerably. Through this funnel with a great wide mouth the fish pass into the trap proper, from which they are not wise enough to extricate themselves. It costs about $20,000 on an average to put down a trap, and it must be taken out in the fall and redriven each spring thus duplicating the cost each season.

A gill net is simply a net stretched across a stream. The fish drive against it and are caught by the gills, being unable to get through or back out. It can only be used in rivers carrying much silt, for the sockeye will avoid it in clear water.

When the sockeye began to disappear a world of controversy arose. The argument was both international and inter-method. Both Canadians and Americans sharply scrutinized the protective laws adopted by their neighbors. The purse seiners blamed the trap men, the trap men blamed the purse seiners, and they both blamed the gill netters.

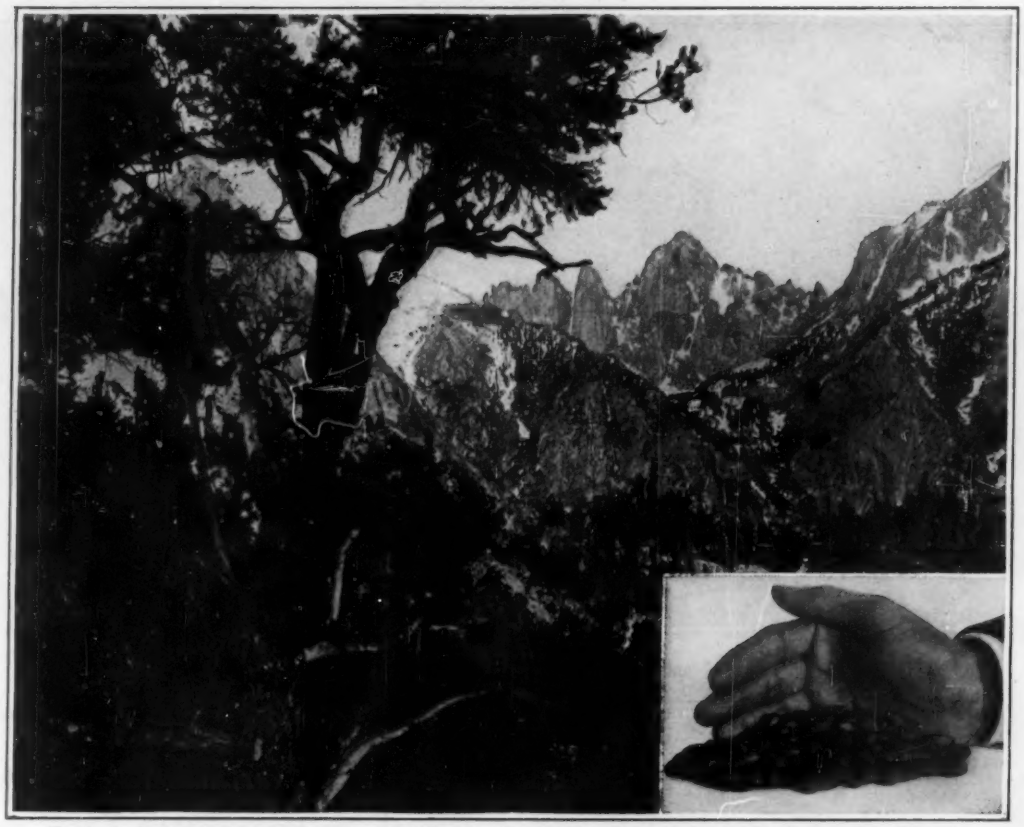
Out of it all came the International Commission which met in Seattle in 1918 and formulated a fishing treaty between the United States and Great Britain. The representatives of the latter were for the most part Canadians. This treaty now awaits action by the United States Senate.

Among other things the proposed treaty eliminates the alien fisherman. At present Austrians predominate in the Puget Sound purse seine industry. But it goes still further, and not only eliminates the alien fisherman who catches the fish, but practically makes a closed season so there will be no fish to catch. The big sockeye run comes every four years. It reaches its height during the last 10 days in July and the first 10 days in August. The proposed treaty provides a closed season from July 20 to 31, inclusive. Thus the cream of the season is cut in two. This is not so bad in the "big run" years—if there are any more such—when half the high tide period and the days before and after will supply ample fish. But in the lean years every fish counts, and one must operat continuously or not at all. A canneryman cannot afford to put down a $20,000 trap and then lose half of the best part of the season. To sum it all up, the canneries would be closed for three years and open on the fourth when the "big runs" come.

The treaty presents a great international reclamation project which can be consummated with little cost, as compared with the work of our Reclamation Service. Up to 1918 the United States Government has spent $125,000,000 in reclaiming 1,100,000 acres of arid lands, which produce an annual crop worth $50,000,000. The waters of the Fraser River basin cover an area of 1,514,000 acres, which, if seeded by spawning sockeye as abundantly as they were seeded twenty years ago, will yield an annual production of 2,000,000 cases of fish worth in the neighborhood of $30,000,000.

California's Pinon-Nut Industry

NOT five persons in a hundred who eat piñon nuts, it is safe to say, could tell what they are or where they come from, how or when they are gathered and prepared, or whether they grow on giant conifers, bushes, or vines like peanuts. The tree that bears them is a decidedly strange single-leaf sprawler known botanically as pinus monophylla. It is unique among all species of this continent. It is a slow grower, not over twenty-five feet high as a rule, with a short trunk, rarely straight, and a wide, rather flat crown of short, heavy, twisted and bent branches which are given off near the ground and usually hang low. The bark of old trees is roughly and irregularly furrowed, nearly an inch thick, with thin, close, dark-brown, sometimes reddish-brown scales. The foliage generally is a pale yellow-green with a whitish, almost bluish tinge, beautiful and restful. Its odor is fragrant, pungent and refreshing. The leaves are stiff, curved toward the branch, prickly, and 1½ to 2¼ inches long. A season's leaf growth remains five to a dozen years, always bright. The tree attains an age of 100 to 225 years. It blossoms one year and the stubby cones mature in autumn of the second season following. By reason of alternation according to localities there is a good yield of seeds nearly every year.



Typical pinon-nut forest of eastern California; the saw-tooth peak in the background is Mount Whitney, twenty miles away. The insert shows 2½ ounces of the nuts

The range of the piñon embraces considerable western territory, beginning in Utah, Nevada and Arizona, from desert altitudes of 2,500 feet up to 10,000, and extending from Lower California to the Canadian boundary. It seems to center, insofar as nuts are concerned, about the Owens Valley, on the Sierra Nevada and White Mountains—the Mt. Whitney region about 250 miles north of Los Angeles. There immense quantities of the chocolate-brown nuts are a virtual certainty every fall. It is an area of approximately 5,000 square miles and one of its best parts is White Mountain Summit, where Westgard Pass, California's grand auto entrance, links east and west via the Roosevelt and Lincoln National Highways and El Camino Sierra. The tree, with roots like steel tentacles, clings to sheer granite cliffs which would appear to be pregnable only to diamond drills and blasting powder. I have seen magnificent specimens haughtily perched on titanic boulders where man could not climb. It flourishes under the withering blaze of the summer sun for many months without moisture and defies such cold blasts and winter gales as high altitudes alone experience.

About Westgard Pass, on nearly a hundred thousand acres, the primitive Indian harvesters from Owens Valley operate today by the same methods employed centuries ago. Hundreds of them are on the ground. They forget all else at this time. Only the squaws toil; the bucks boss the job, sell any surplus and pocket the proceeds. The task requires five or six weeks. It is a harvest fraught with hardship, involving long journeys to and from the lofty habitat of the piñon. Water always is scarce, too, but this in itself is no great deprivation to an Indian since he uses but little and that for drinking purposes only. The nut and the "peaggie" are necessaries to this people of whom 1,700 remain in the valley. The "peaggie" is a large, plump, greasy white worm found by the millions in the Mono Lake region. It is very juicy in its fresh state but appears to be relished more when dried. It looks quite as toothsome to the white man as the shrimp to the Indian; and of course no self-respecting Piute would tackle a shrimp or an oyster. The "peaggie" adorns giant pines much as the well-known tomato worm decorates those vines. It drops off at certain seasons, when it is raked up to be later converted into soup and a more or less delicate dress-

(*Continued on page 15*)

Left: Kernels in place, with one flap folded. *Center:* A number of the testers undergoing the germinating test. *Right:* A tester ready for soaking

The rag-doll seed-tester which serves to determine the germinating qualities of seed

The Rag-Doll Seed-Tester

THE rag doll has a purpose other than amusing the baby, its latest formation being that of divorcing the faulty ears of corn from the sound ones by germination tests. The home-made equipment takes its name from the shape assumed when the corn is wrapped in bleached muslin and soaked in lukewarm water that the kernels may sprout, as a method of betraying unsound seed.

The photographs describe how bleached muslin has been cut into strips 16 inches wide and from 3 to 5 feet long, and sections defined and numbered for laying kernels of corn thereon. After moistening the tester, the kernels, about ten in number, are placed in the different sections, care being exercised that the different samples are not mixed. The outfit is so folded that the edges form company in the middle, the muslin being pressed down firmly over the corn. A cob or other rounded object is used as a core around which to roll the tester, a cord or rubber band around the middle completes the formation of the doll.

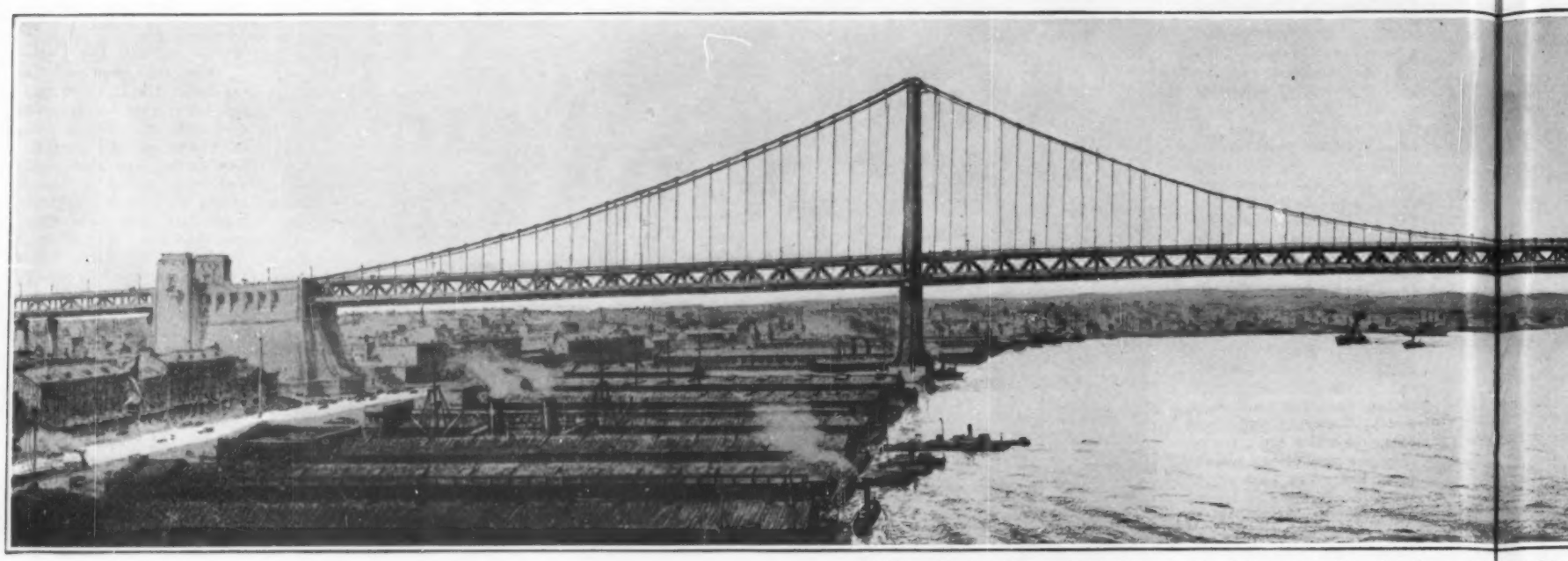
Dolls—that is, rag-doll seed testers—are soused in lukewarm water, taking an uninterrupted bath of from 2 to 4 hours, 10 being the maximum. The testers are removed, water permitted to drain therefrom, and placed in a warm and moist atmosphere, not being subject to a temperature outside the marginal figures of 50 and 100 degrees Fahrenheit. Good and bad germinations are reflected by the samples, suggesting the discarding of faulty lots.

A New Means of Carrying Plant Disease

THE experts of the Federal Department of Agriculture have recently discovered through investigating cucumber-leaf wilt an unknown method, heretofore, of plant disease carrying. It is claimed that the striped cucumber beetles carry the wilt bacteria in their jaws and when they gnaw into a leaf the infection is spread. In some cases the bacteria is carried over in their intestinal tract throughout a winter and in the spring are deposited so that the first time they come into contact with a broken or gnawed leaf infection is spread. This is the first instance known to scientists where insects carried bacteria through an entire hibernation period to do damage in the spring.

A Scientific Exposition

THE Sociedad Astronomica de España y America will celebrate the tenth anniversary of its foundation by holding a scientific exposition at Barcelona, Spain, in October, 1921. The scope of the exposition will comprise chiefly astronomy, meteorology and seismology, and the observatories, universities and other scientific centers of the world are invited to send exhibits in the shape of documents, books, photographs, old and modern instruments.



Bridge about to be constructed across the Delaware to join Camden and Philadelphia.

Bridging the Delaware

A Two-Cable Suspension Bridge with a

WORK is to be started within the next few weeks by the Joint Delaware River Bridge Commission of Pennsylvania and New Jersey on a suspension bridge which will span the Delaware between Philadelphia and Camden, a distance of 1,750 feet. The main span will be 1,750 feet between towers with a clearance of 135 feet above high water. It will be hung from two thirty-inch cables, each made up of 16,531 wires, 0.192 of an inch in diameter, and all parts of the bridge will be designed safely to withstand a live load of 11,990 pounds per lineal foot.

The main span of this bridge will be forty feet longer than that of the cantilever bridge over the Firth of Forth, and fifty feet shorter than the main span of the Quebec Bridge. It will thus come third in length of main span when the bridges built or about to be built, are completed. First is the Hudson River Bridge 3,240 feet; second, the Quebec Bridge, 1,800 feet and third, the Philadephia Bridge, 1,750 feet. About 33,000 tons of metal will be required, as compared to an estimate of 47,000 tons for a cantilever bridge over the same river. The cost is estimated by the board of engineers at $28,871,000, of which $22,479,000 covers the entire construction cost and the rest provides for the acquisition of real estate necessary for the approaches.

The Board of Engineers which recommended this bridge consists of Ralph Modjeski of Chicago, one of the world's well-known bridge builders, George S. Webster and Laurence A. Ball. Their report was submitted after six months of investigations and surveys during which five available sites within limits prescribed by an act of Congress were studied and compared. Their estimate of the probable cost, based on existing market figures, runs from ten to twenty million dollars below the rough calculations of engineers and other experts who have made casual studies of the bridge project in Philadelphia.

In their report the engineers set forth that a suspension type was selected for the reasons that it involves less risk in construction, is $1,986,000 cheaper than the cantilever type and can be erected more quickly, saving possibly an entire season. They also point out a possibility with a suspension bridge that does not exist with the cantilever type, namely, that provision may be made for increased capacity after completion if that is ever found necessary, and also that the suspension type has less exposed surface of metal to be kept painted,

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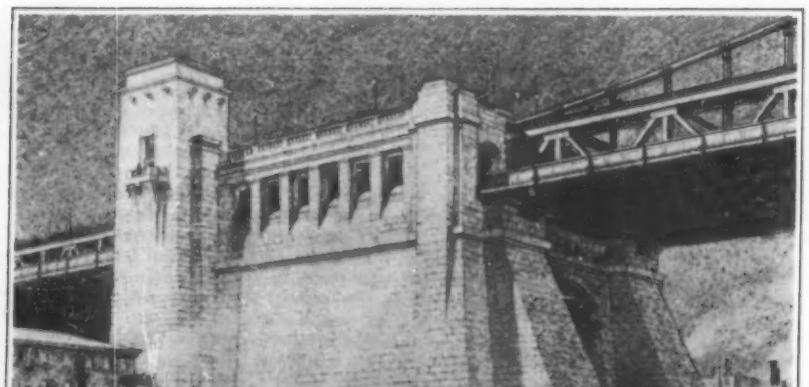
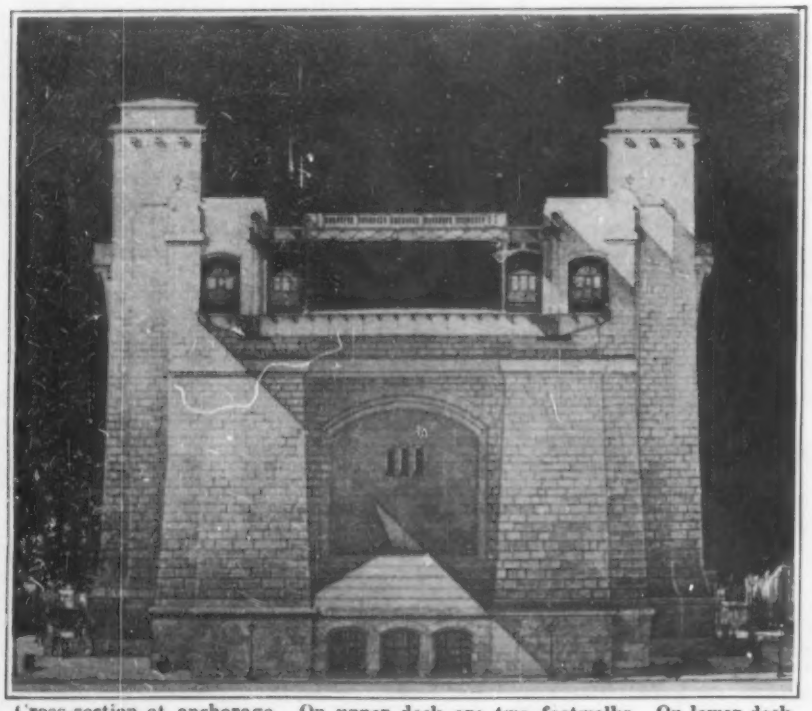
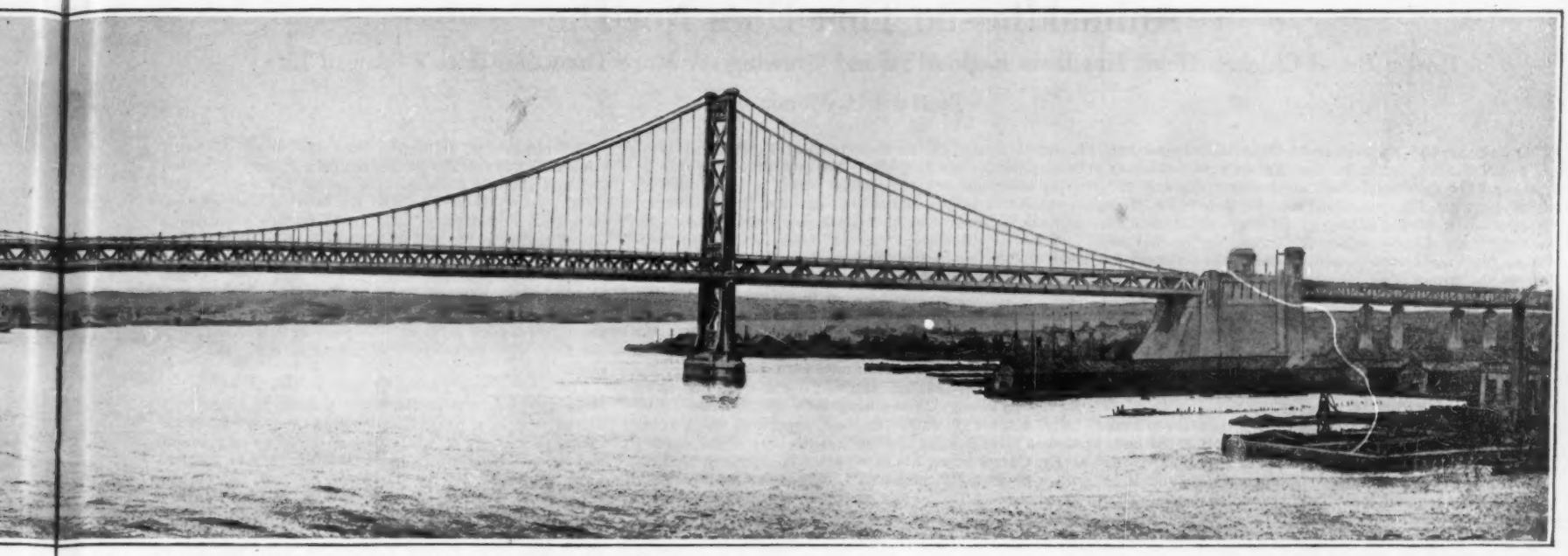


Anchorage showing buttresses, inclined in the direction of the resultant stress



Cross-section at anchorage. On upper deck are two footwalks. On lower deck are two trolley tracks, 2 rapid-transit tracks, and a 57-foot roadway

Airplane view of a plaza and approach to the



and Philadelphia. Main span 1750 feet. Two wire cables, each 30 inches in diameter

elaware at Philadelphia

Bridge with a Main Span of 1750 Feet

and is therefore more economical in maintenance.

The engineers went to New York's four great East River bridges for "a working laboratory for the study of bridge roadways and their capacity." When the Manhattan Bridge was designed a single 35-foot roadway was considered wide enough for four lines of travel, two in each direction, and this was placed on the center line of the structure.

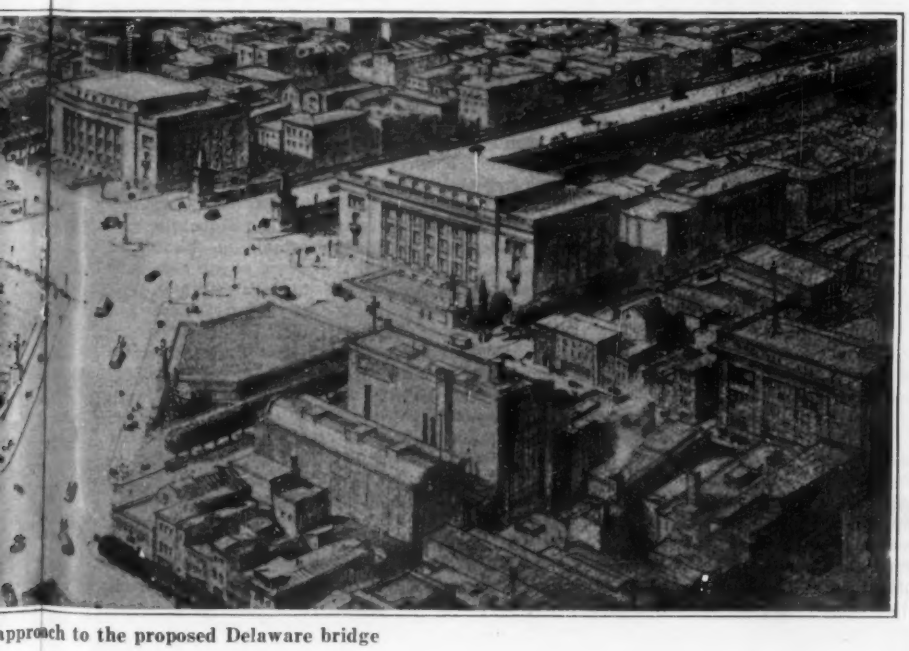
The Queensboro roadway which is fifty-three feet two and a half inches between curbs, possesses great flexibility, and for this reason is very popular with all drivers. It can handle almost double the traffic of a four-lane roadway like that on the Manhattan Bridge. Accordingly, the engineers provided for six lines of traffic on the Delaware Bridge, increasing the width for each line to nine feet six inches to care for the largest trucks, and fixing the width from curb to curb on the main structure at fifty-seven feet. Room also is provided for two lines of track for a bridge shuttle service, and two more for an extension of the city's high speed transit lines over the bridge when that facility is desired.

Designs were laid out so as to have no roadway grades in excess of three and a half per cent. On the transit tracks it was kept near five per cent, with a maximum of 5.22 per cent for a short distance into the subway connection. The main piers are to be 380 feet high and 60 feet wide. The total live load computation provides for a total of 11,990 pounds.

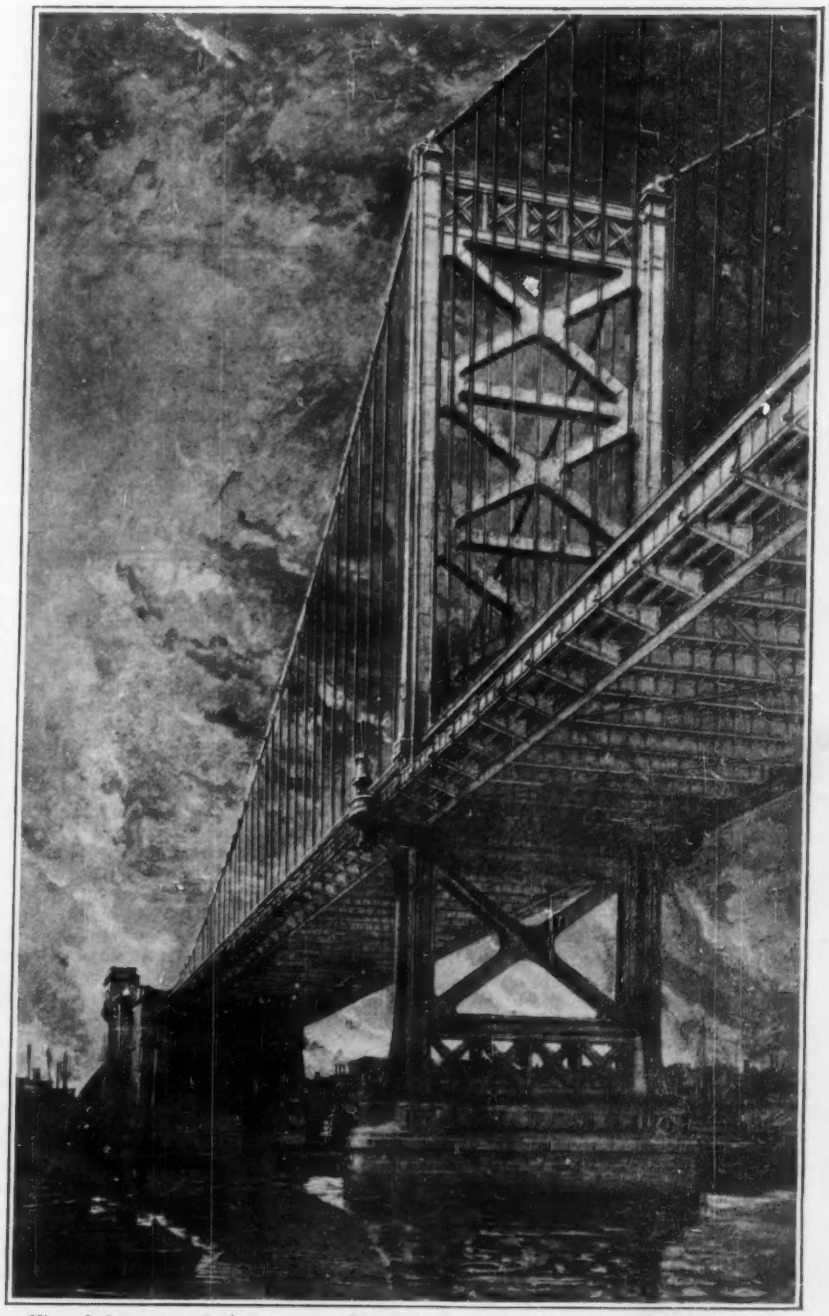
The roadway floor was designed to carry at any point a moving load of 30 tons. Concerning dead load the report says that preliminary assumption of the dead load was based on information as to the weight of similar structures. A computation of stresses was made on this basis and the sections of the members determined. Estimates of the weight of the structure were then made from these sections and the stress figures revised. This procedure was repeated twice. A complete check of weights, made after the design had been fully determined on, did not show enough change to require any further revision in stresses. Wind loading was considered to cause a pressure of fifty pounds per square foot of exposed area. Temperature stresses were computed for a variation of 55 degrees above and below a normal temperature.

All main truss members, towers, floor

(*Continued on page 15*)



pproach to the proposed Delaware bridge



View below one of the towers. Note the two 30-inch cables, in place of the customary four cables

Animal Tissue That Does Not Die

How a Bit of Chicken Heart Has Been Kept Alive and Growing for More Than the Chick's Span of Life

By Harry A. Mount

TO help us find an answer to the vitally important questions set forth in the Editor's introductory note we have developed medicine and surgery and the allied sciences. Through these we have come to a little understanding of the nature of life and of death and we have been able to reduce the number of premature deaths from accidental causes (these include diseases). But we have not been able to lengthen the maximum span of life.

Those who die natural deaths, that is from old age, live about the same number of years now as among the earliest of our ancestors of whom we have any record. The greatest age attained by any of us is about 100 years and this only in very rare instances. In fact a thorough examination of most of the cases of this extreme old age of which we hear frequently fails to bear out the claims. It is extremely doubtful if there have been, in the past century, more than five or six persons who lived to be more than 105 years of age and it is probable that none of them lived beyond that age. This statement is based upon scientific investigation.

It is rather startling then, when men of unquestioned scientific standing tell us that all of the essential tissues of the body are potentially immortal and that, barring accidents, we ought never to die! This is the newest evidence the science of medicine has to offer; and it is evidence, mind you, not theory. Experiments which point to this conclusion have been carried out successfully for a number of years but now we have the final proof:

A skilful surgeon has been able to keep alive by artificial means, outside the animal, a bit of tissue for a longer time than the natural span of life of the animal itself. The remarkable thing is that the tissue is no longer subject to the influence of time and there is no doubt that if properly cared for it will live on indefinitely—forever if you would have it so.

The surgeon is Dr. Alexis Carrel of the Rockefeller Institute in New York and his experiment is with a bit of connective tissue from the heart of an embryo chick, which he has kept alive and growing for more than eight years.

This experiment alone might not be conclusive, but in connection with the work of other scientists its meaning becomes clear. Not only is it possible to cultivate artificially the growing life-cells of an embryo chick, but this has also been done successfully (although for shorter lengths of time) with cells from various parts of the human body, as nerve cells, muscle cells, heart muscle cells, epithelial cells from various locations in the body, kidney cells, and connective tissue cells.

"We may fairly say, I believe," says Prof. Raymond Pearl of Johns Hopkins University, Baltimore, "That the potential immortality of all the essential cellular elements of the body either has been fully demonstrated or else has been carried far enough to make the probability very great that properly conducted experiments would demonstrate the continuance of life in these cells to any definite extent." Couched in the cautious language of the scientist, the statement is none the less significant.

Perhaps it would be well to review briefly the work of some of the other experimenters before describing in detail Dr. Carrel's remarkable work. The idea of cultivating artificially certain cellular plants, as yeast, and some of the lowest forms of animal life, as the microscopic single-cell animals, is not new to most of us. But keeping portions of the organisms of the higher animals alive and growing was not so long ago regarded as impossible.

The idea that it might be done is due to the work of Dr. Jacques Loeb, also of the Rockefeller Institute. Dr. Loeb was experimenting with the artificial fertilization of frog eggs and actually succeeded in raising several specimens from eggs that had not been fertilized. He became interested in the problem of why some of the eggs, which did not meet just the proper conditions, died. This led him to investigate the cellular life of the frog itself and he was able to keep portions of the frog alive outside the organism for considerable periods.

Dr. and Mrs. Warren H. Lewis of Baltimore then made the important discovery that tissues of the chick embryo could be cultivated outside the body in pure inorganic solutions, as sodium chloride, Ringer's solution, Locke's solution, etc. No growth took place in these solutions, but the tissues could be stimulated to slow growth by the addition of calcium and potassium, maltose, dextrose, or protein decomposition products.

Other experimenters carried these results still further and it was found that nearly any animal cellular tissue could be cultivated, in much the same manner as yeast is grown, in a solution of liquids taken from the blood and tissues of the animal. But one of the experimenters, Harrison, objected properly that while the evidence pointed to the probability that these tissues could be kept alive indefinitely with proper care, the old assumption that old age and death were due to an inevitable change in the body cells would never be totally disproved until someone succeeded in keeping tissues alive beyond the natural lifetime of the animal.

Dr. Carrel began his experiment on January 17, 1912, when he took sixteen small fragments of the heart and blood vessels from embryo chicks seven to eight days old. In March, 1912, only five of these fragments were alive. In May, 1912, these had grown until over 25 cultures were alive. On June 1, 1912, Dr. Albert H. Ebling took charge of the cultures but due to bacterial infections many of them died and on July 1 only five survived, but these were growing actively. On September 1 all were in good condition but a number of technical accidents reduced the number on September 25 to a single culture. This culture was from a fragment of connective tissue derived indirectly from the fragment of a heart, "which," to quote Dr. Ebling, "still pulsated after 104 days of life *in vito*."

On October 23, 1912, the single remaining culture began to increase rapidly in size and was divided into two parts. On November 17 there were twelve large cultures derived from these and in January, 1913, there were thirty cultures. In July, 1914, the experiment was proceeding so satisfactorily that Dr. Carrel made his first public report of its progress. The tissue was then 28 months old. Dr. Carrel made a second report of the condition of the tissues on July 7, 1919, when the culture was over seven years old and had undergone 1,390 passages from one solution to a fresh one. The fragments of tissue are allowed to grow for 48 hours undisturbed and then divided into four parts, washed in Ringer's solution, and transplanted to fresh media. Dr. Ebling thus describes the complicated process of caring for the cultures:

"The fragments of tissue are transferred by means of a knife point to the medium (which has been spread on a microscope slide). They are imbedded thoroughly in it without folding or curling. This step must be carried out rapidly to guard against imbedding after coagulation has set in; that is after fifteen or twenty seconds under ordinary conditions of room temperature and moisture. Coagulation is allowed to proceed and occurs in from 45 to 50 seconds. During this period, as well as during the period of washing in Ringer's solution, the preparations are kept under a large Petri dish in order to eliminate as nearly as possible chance bacterial contamination from the dust of the atmosphere.

"After coagulation the cover dish is inverted and placed on a hollow slide and is held in place by a small amount of vaseline. The cover dish and slide are then sealed with paraffin melted at 56 degrees centigrade and placed in an incubator kept at 39 degrees centigrade."

The medium now employed consists of equal parts of chicken plasma and chicken embryo extract. This produces a clot firm but not dense enough to interfere with migration of the cells.

The plasma is extracted from the blood of adult chickens. The chicken is first fed on a strictly regulated diet and then is given nothing to eat for a day. The carotid artery is severed and the blood drawn off into chilled paraffined tubes. The blood is then placed in a centrifugal machine and whirled at high speed, separating the solid from the fluid parts. The fluid is placed in glass tubes, sealed with paraffin and kept in cold storage until needed. The chick embryo extract is made from embryos seven or eight days old. These are minced with scissors, the pulp centrifugated, and the fluid thus extracted also placed in cold storage in sealed tubes.

The area of new growth of the cultures at the end of forty-eight hours is measured by placing the slide with the culture in a projecting machine and throwing the image to a sheet of white paper. It is quickly traced and the new area afterward calculated. A soft, diffused light must be used in the projector and the culture exposed as short a time as possible to avoid injury. In measurements of 142 cultures it was found that the area increased from four to forty times in a period of 48 hours. Dr. Ebling enumerates four conclusions from the experiment:

1. A strain of connective tissue is still very active after years of life *in vito*.
2. The rate of growth of the fragments of tissue can be measured accurately and used for testing the action of many different factors contributing to the growth.
3. The rate of growth of the strain is at least as rapid as it was five years ago, if not more so.
4. The connective tissue cells appear to have the power of multiplying in a culture medium, as do microorganisms.

The remarkable development recently brought out has been the observation that the culture is no longer subject to the influence of time. There is no apparent "aging" of the individual cells and under uniform conditions the tissue continues a uniform rate of growth. As will be observed from the early history of the culture, the progress then was erratic and uncertain. This may be blamed partially on the fact that the technique of handling the cultures had not been fully developed, but probably partially to the fact that the living cells had not become "acclimated" to their new environment. But apparently they are now quite at home and will continue to live and thrive as long as the patient scientists at Rockefeller Institute continue to care for them.

Matter of fact as it all sounds, it is a venture out into the sea of darkness, not so dramatic, but perhaps more far-reaching than the voyage of Columbus.

Our bodies are potentially immortal!

All these years while we have observed old age creep up on a man and finally lay him low and have said "It is inevitable; it is the fate of all" we have been wrong. The change in cell structure which accompanies old age is not the cause of old age but a result.

The result of what? What really sets a limit to the duration of human life? Professor Pearl reasons that while we are theoretically immortals, the reason we are not actually so, is because of the very complexity of the human body. "In the body," he says, "any part is dependent for the necessities of existence, upon other parts; upon the organization of the body as a whole. If one part fails, there is failure in other parts dependent on it and the whole machine collapses. But it would appear that so long as we can prevent a breakdown of any one part, we shall continue to be young and vigorous.

What then is the span of human life? Fourscore years and ten? Actually the average is less than that. So far the probability that a man would die of disease has been so great that there was little chance of his living the maximum number of years. Considerable progress has been made in the fight on disease but we have been so busy with that fight that little has been done in a scientific way to push back the hundred-year mark which seems to have been the limit of existence.

Indeed, we have just found the basic principle upon which a successful attack on old age can be made. Perhaps the day is not so far away when most of us may reasonably anticipate a hundred years of life. And if a hundred why not a thousand?

WE are, all of us, essentially selfish creatures. No matter how intently we may be interested in our jobs, our families, our science, or our charities, we are, first of all, interested in ourselves. We are interested in living our own lives and after that in the people and events about us. We are interested in these in just the proportion that they affect our own lives. And the most interesting thing about life is—life itself. What is life and what is death? How long ought we to live and why do we die? Can life be prolonged? It is the efforts of the Rockefeller Institute to solve these and related questions that Mr. Mount describes on this page.—THE EDITOR.

The Condensing of Milk

How It Is Carried Out and Its Economic and Vital Importance to the Country

By Robert G. Skerrett

GOVERNMENT authorities have recently stated that the American people consume annually an average of 44 gallons of milk per capita. But how many of us know anything about that large industry which is devoted to treating milk so that it will keep for months or years, stand transportation to distant points, and be fit for food in any climate? The condensing of milk is a business of splendid proportions in this country.

From a modest beginning in 1856, when milk was first condensed successfully on a commercial scale, factories have gradually increased in number and amplified in their facilities until they represent today engineering developments of the highest order. Step by step the technicist has improved apparatus and processes so that the product can be turned out now of uniform quality and measuring up to standards deemed practically impossible of attainment in quantity a comparatively short span back. The significance of this is of profound interest, for as the years go on we are becoming less self-sufficient in the matter of native food supplies, and it is growing more and more vital to us that we limit waste and provide ways by which our perishable comestibles can be preserved for delayed use.

Milk, as we have been told time and again latterly, is a so-called "complete food," peculiarly suited to the nourishing of the young, invalids, and persons of advanced age. But it is equally true that every one of us would be the better off physically if we saw to it that milk entered more generously into our daily dietary. It is especially qualified to furnish nutritive factors perhaps lacking in other edibles which frequently predominate in the average fare—in short, milk can do much to insure the balanced ration essential to bodily well-being.

While nationally viewed, each of us may seem to have at his disposal annually an allowance of 44 gallons of milk, there are many thousands of our fellow citizens that are not so favored. This is noticeably the case in the Southern States, where the natives eat much less of animal foods, such as milk and lean meats, than do others of us who are the beneficiaries of different agricultural conditions. For this reason as has been brought to light of late, pellagra, a disease of malnutrition, is one of the foremost causes of death in the South; and recent figures disclose that fully 125,000 persons are afflicted with it in the course of a twelvemonth. The U. S. Public Health Service has not hesitated to say that "Milk is the most important single food in balancing the diet and in preventing or curing pellagra." While the dwellers in that widespread region cannot get fresh milk or enough of it, still, happily, canned milk can be supplied them in plenty. But enough upon the physiological and therapeutic virtues of this topic, for the purpose of this article is to point out the economic aspect of the condensed milk industry and what it stands for in the realm of true conservation.

Thirty years ago the total production of condensed milk here was substantially 37,927,000 pounds, valued at $3,587,000. In 1900, the condenseries turned out 186,922,000 pounds worth at that time $11,889,000. Nine years later the production reached 494,797,000 pounds, quoted at $33,563,000. In 1919, the 240 plants engaged in the business put up 2,030,958,000 pounds of condensed milk of different kinds, which had a market value of approximately $200,000,000. During the decade from 1909 to 1919 the volume of the production increased 410 per cent! This expansion can be properly attributed to the popular recognition of the character of the commodity obtained through the employment of scientific and typically up-to-date processes. And that we may understand the methods used, let us sketch the procedure in vogue at one of the most modern of condenseries.

After passing the rigid inspection at the receiving room, the raw milk is weighed and then discharged into a large storage vat or enamel-lined tank equipped with power-operated paddles which keep the milk in motion so that the cream cannot separate from the mass and rise to the surface. The storage tank is generally supplemented by a number of containers—all of them cooled by water jackets—and in these the milk is continually agitated or stirred by rotating sweeps.

Next, the raw milk is fed into what are termed hot wells, deep, open, iron vessels where the fluid is heated sufficiently to kill all contained harmful bacteria, etc. The hot wells are only partly filled, but, when the temperature has been raised to the point desired, the milk expands rapidly and rises in a foamy mass to the top of the containers. When this stage is reached the steam is turned off. About 2,000 pounds of milk are handled at a single heating. Now comes the condensing.

This concentration is effected in large copper vacuum pans or kettles, each of which is capable of treating 100,000 pounds of fluid milk daily. The purpose of the vacuum pans is to promote the rapid evaporation of much of the water content and to achieve this without recourse to a temperature that will cook the milk the while. If the milk were subjected to a temperature of 214 degrees—its boiling point—it would acquire a flavor which is objectionable to many people, therefore vaporizing must take place well below this. A vacuum of about 28 inches occasions ebullition somewhere around 100 degrees Fahrenheit. Interposed between a powerful vacuum pump and the dome of the vacuum pan is a water-jacketed condenser, and as the steam is drawn off by the suction the condenser deals with it. Gradually, the milk thickens as the steam coils in the pan promote evaporation; and when successive tests show that the density has reached the prescribed point the process is halted, and the condensed milk is drained off. It takes about two hours to effect the concentration.

Leaving the vacuum pans, the milk is put through a special apparatus called a homogenizer. This

(*Continued on page 16*)

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

The High Cost of Flying

To the Editor of the SCIENTIFIC AMERICAN:

Here's something you probably didn't know. I quote from a San Francisco paper, which explains why Japan has barred all platinum exports by telling the applications of this metal. "Its essentiality to war activities is seen in the fact that platinum is the only metal that will stand the intense friction of the contact points in airplane engines. All bearings are coated with it."

It would appear that the flivver of the skies is a long way off. Or perhaps Mr. Ford will evolve some process for substituting gold and silver for platinum in airplane bearings, and thereby bring these craft within the reach of all.

San Francisco. C. E. RANDALL.

Wages vs. Prices

To the Editor of the SCIENTIFIC AMERICAN:

Apropos to the series of articles you have had on the labor question, I suggest the following for your consideration:

That the Federal Government appoint a permanent board having the confidence of the laboring classes, whose function shall be to fix the relative scale of wages and the working conditions covering the labor employed in the various industries of the country. The rate of wages shall be based upon the labor, skill, and danger involved in the occupation. Once the rate is determined it should become the law of the land, equally binding upon employer and employee with adequate penalties to insure its enforcement.

This body, at its first meeting, naturally, will not evolve a perfect schedule, but through its power of investigation, and by studying the drift of labor, it will eventually determine a schedule which will be approximately just. At its worst, and in the very beginning, the results obtained will be far better than the results obtained under the present system where the wages paid are determined by the relative power of the employers and the employees of an industry, and the position of that industry, with little regard to the actual comparative value of the work performed.

The principle underlying the above suggestion is, that each man should be able to buy back from the common fund of wealth produced that part which he has contributed to it and therefore its determination rightfully belongs to society and not to any individual or group of individuals.

The results of the above would be:

1. To reduce the present antagonism between capital and labor.
2. To prevent strikes, for, as the determination of the rate of wages will not lie with the employers, it is hardly conceivable that any body of men will strike against society.
3. To put every industry and every investor, irrespective of location, on the same competitive basis with regard to its labor.
4. To prevent excessive rise in price based upon claims that wages have been advanced, or labor was inefficient, as has been the case last year.
5. To obviate the necessity of delegates with their abuse of power, also the existence of dishonest labor leaders and employers.
6. To do away with child labor and women labor under certain undesirable conditions.
7. To maintain the rate of wages at a time as at present, where it is absolutely necessary that the purchasing power of the country be maintained in order to preserve old values and restore confidence.
8. To prevent depression, for, with wages standardized, commercial loans will show if merchandise is going into consumption or accumulating on the market.

New York. JEROME LEVY.

The Cost of Multiple-Arch Dams

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of February 5, 1921, page 108, appears an article by J. F. Springer, describing some of my work. As the designer of this type of dam, and the builder of 14 as well as designer of about 20 more under contract and prospect, it is to my interest that the descriptions of this work be accurate. Of course, many expressions and statements of a non-technical writer who writes of technical things must be overlooked, for they are apt to have statements made to them by the ill-informed that they are not in a position to refute or to correct. It would seem to bear out the statement of doubt as to the economics of this type of dam when we read in his article that the cost of the Lake Hodges Dam, "exclusive of accessories," is $4,000,000. It is an error that I should be permitted to correct through your paper, for as a fact the actual overall cost of this dam to the company was, "*inclusive* of all accessories," $302,212, which is a far cry from *four millions*.

The San Dieguito Dam cost but 78 per cent of the lowest bid for a plain earth fill. The Murray Dam, which is fairly well described, cost $124,454 overall, and as it is 900 feet long and 117 feet high, it is surely a record for economy of cost.

The remarkable scientific features of these dams will be very interesting reading to the scientific world, not only the economics, but the features of their design. JOHN S. EASTWOOD.

Oakland, Cal.

Mr. Love's Cycle-Car

To the Editor of the SCIENTIFIC AMERICAN:

Your article on the "Vest-pocket Automobile" in the issue of April 30th includes some remarks based on a communication I made you some time ago with reference to an illustration appearing at that time. This illustration purported to be "a home-made flivver," and if you refer to my original communication you will find that I was of the opinion that it was really a "Tamplin" cycle-car with "roller-blinds, chip-carving and other home-made improvements." In proof of which opinion I sent you a photograph of the "Tamplin" I purchased last spring, which photograph you reproduce now with accompanying letter-press which might make the reader infer that it was a "V. P. A." reconstructed by me from something else. I must apologize if my bad American has been responsible for the misunderstanding and I should be glad if you can publish this letter as your circulation in Great Britain is doubtless large enough to make your article as it stands against the best interests of the makers of the vehicle in question with whom I have no other relation than as a very satisfied customer.

Lee, England. ANGUS LOVE.

The Heavens for July, 1921

What a Study of Atoms aud Electrons Tells Us of the Stars

By Henry Norris Russell, Ph.D.

IT is becoming more and more evident, as both sciences advance, that the astronomy of the future will be intimately associated with and dependent upon the concepts and the results of physics, and especially of that branch of physics which deals with the constitution and properties of atoms. Our knowledge within the latter field has been very greatly extended within the last decade, and many astronomical observations which before were puzzling have thereby been explained.

This is particularly true in the realm of spectroscopy. The main facts regarding the emission of light by hot bodies, and by hot gases in particular, have been known for many years; but it is only recently that we have even begun to have an idea of the processes taking place inside the atoms of the gas, which are involved.

For example, when the vapor of a given element, such as calcium or iron, is confined in a heated tube or "furnace" and observed through the end of the tube, the spectrum of the light which it emits shows certain bright lines. If the temperature is raised these lines grow stronger and new lines appear in addition. When the same metal is brought into an electric arc (which is hotter, and also subject to direct electrical action), more lines appear; while a yet more advanced stage may be reached by passing a powerful spark, fed by a source of current of high tension, between two bits of the metal; and in the spectrum from this lines may be found which were not to be observed at any of the lower stages of temperature.

Extensive studies have been made of these phenomena, and long lists of "furnace" and "spark" lines compiled, with important astronomical applications. But the physical explanation, from the atomic standpoint, lagged behind, and came only with the application of the modern quantum theory, which has been remarkably successful.

Why Are the Spectral Lines?

We have good reason to believe that an atom of any element consists of a central, and very small, nucleus, carrying a positive electrical charge, surrounded by a number of negatively charged electrons, which under the system of forces acting between them and the nucleus arrange themselves automatically in a definite pattern, probably consisting of several concentric shells or layers, at least in the heavier atoms. In the hydrogen atom there is but one electron; in helium two; in oxygen eight; in sodium eleven; in iron twenty-six; and so on up to 82 for lead and 92 for uranium. The inner electrons are held by very powerful forces, and are hard to dislodge; but a few of the outermost are relatively easy to displace, and it is these which are concerned in the chemical affinity between atoms of different sorts, and also in the production of the radiation of the visible spectrum. To pull one of these electrons away from the rest of the atom, or as it is called to ionize the atom, demands a certain expenditure of energy; and this produces an absorption of light by the gas of which this atom is a part. When some other free electron comes near to the ionized atom, it will be attracted to it (provided it does not go by too fast); and, in falling back, a corresponding amount of energy will be emitted in the form of light radiated by the gas.

Recent research has shown that this is but part of the story. There appear to be many different positions in which the electron can stop, short of being pulled clear away from the atom. The farther out it gets the more energy is required to raise it—the greatest amount of all corresponding to the complete removal of the electron, or the ionization of the atom.

Now when an electron changes from one of these states to another, light is absorbed, if it is pulled up to a "higher level" nearer the outside of the atom, or emitted if it drops to a "lower level"; and this light consists of vibrations at a perfectly definite rate, giving a sharp line in the spectrum. The most remarkable feature remains to be mentioned. The number of light vibrations per second is exactly proportional to the amount of energy which is required to pull the electron up from one position to the other, or is liberated when it comes back. The reason for this famous "quantum relation"—and indeed the reason why the various possible positions for the electron should exist at all—remains still a mystery, which is regarded by the ablest physicists as one of the hardest problems of science. But the fact has been tested in so many ways that no doubt remains.

When the spectra of the elements are studied from this standpoint it is found that the furnace lines correspond (in the case of absorption) to the raising of the electron from the very lowest "level" at which it normally is situated in the undisturbed atom to various higher levels; while the arc lines, in general, correspond to the raising of the electron from one of these higher levels to another. When light is emitted we have to do with an electron falling back over one of the same intervals.

The enhanced lines correspond to still another process. After one electron has been taken clear out of the atom, it is often possible, by a greater force, to pull a second electron out, and doubly ionize the atom. In this process too there are various possible "levels" between which the second electron may shift, and a corresponding set of lines, all quite different from the furnace or arc lines. It is even possible that an atom may lose a third or actually a fourth electron, and there is reason to suppose that some spectral lines, produced only in very violent sparks, are of this origin.

At 11 o'clock : July 7.
At 10½ o'clock : July 14.
At 10 o'clock : July 22.

At 9 o'clock : Aug. 7.
At 8½ o'clock : Aug. 14.
At 8 o'clock : Aug. 22.

At 9½ o'clock: July 30.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on July 7, etc.

NIGHT SKY: JULY AND AUGUST

What It Means to the Astronomer

With these ideas in mind it is very easy to see why the furnace lines are characteristic of the red stars, like Betelguese; the arc lines of yellow stars, like the sun; and the spark lines of very white stars, like Sirius. In the hot atmospheres of the stars, the atoms collide and jostle one another. The red stars are the coolest, and the collisions are the least violent, so that most of the atoms are in their undisturbed condition, and absorb only the flame lines. In the hotter atmosphere of the sun many of the atoms are jostled so that the electrons within them are raised to higher "levels" and are in a position to be raised further, with absorption of the arc lines. Finally, in the still hotter white stars most of the atoms are completely ionized, and are therefore ready to have a second electron removed, with absorption of the light corresponding to the spark lines. For some elements, such as calcium, this process occurs with relative ease; hence the spark lines of calcium—the great H and K lines in the violet—appear strongly in the sun. Helium on the other hand is the most difficult of all the elements to ionize; and the amount of energy required even to lift an electron from the lowest "level" to the next above is so great that the corresponding light vibrations are exceedingly rapid, and lie so far in the ultra-violet that all ordinarily transparent substances are opaque for them. The visible lines of helium correspond to a lifting of an electron from the second, or even a higher level to one still above, and can only be produced in an atom which has already been violently jostled, so as to throw the electron up to the second "level." This explains why the absorption lines of helium are found only in the very hot stars, like those in Orion. Spark lines of helium, corresponding to the loss of a second electron, are known; but these are found only in a very few stars which, from other evidence as well, we have reason to believe to be the hottest in the heavens.

Many beautiful applications of this theory have recently been worked out by an Indian physicist, Dr. Megh Nad Saha, of the University of Calcutta. Much of the foregoing discussion is adapted from his work, and one more instance of it may be given. The dark lines of sodium are strong in the solar spectrum. Those of potassium are present, but weak. The rare alkali metals, rubidium and caesium, show many strong lines but these do not appear in the sun at all. This has long been a puzzle, but Dr. Saha has given the solution.

Laboratory experiments have shown that it is fairly easy to remove an electron from a sodium atom, easier to get one out of a potassium atom, and still easier for rubidium and caesium. To get a second electron away from any of these atoms, after the first is gone, is however very difficult. Calculation shows that, in the sun's atmosphere, sodium vapor should be largely ionized, with however a considerable percentage remaining un-ionized atoms, which still retain one electron that may be removed by the action of light, with absorption of the well-known sodium lines. For potassium, almost all the atoms are ionized, leaving very few in a position to produce the absorption lines. Rubidium and caesium, still easier to ionize, would be completely ionized, leaving no atoms at all in a position to produce the absorption lines which are so conspicuous under the less extreme conditions of our laboratories. Hence the weakness of the potassium lines, and the absence of those of the other elements, is completely explained.

When more laboratory work has been done (largely by electrical methods) on these matters, it probably will be possible to calculate with fair precision the temperatures of the atmospheres of the various types of stars, simply from a knowledge of the degree to which the various sorts of atoms in them are ionized, as indicated by the lines in their spectra.

The Heavens

At our hour of observation Vega is almost overhead. Cygnus is high in the east, and Aquila in the southeast, a little lower. Below it lie Capricornus and Aquarius, and to the right, due south, is Sagittarius, with Scorpio to the west of it, and Ophiuchus above the latter. Bootes is the most conspicuous western constellation, with Corona above it and Hercules almost overhead. Ursa Major is in the northwest, Ursa Minor and Draco in the north, Cassiopeia and Cepheus in the northeast, and Pegasus has just risen in the east.

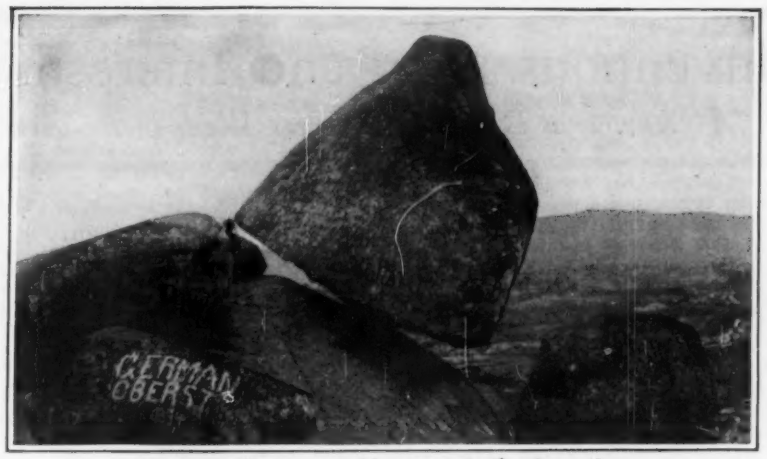
The Planets

Mercury is an evening star at the beginning of the

(*Continued on page 16*)

A Rocking Stone from Buenos Aires

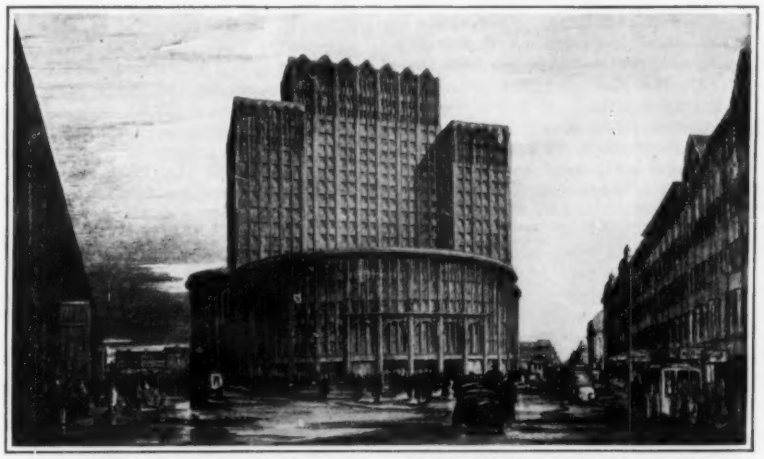
THOSE who are familiar with the sights of Bronx Park, New York, know what a rocking stone is. For others, it may be explained that the term refers to a boulder of decent size that has been deposited, usually by glacial action, on the surface of rocky ground in such a way as to sway back and forth under the application of pressure from the wind or from a human hand, without toppling completely over. The phenomenon must obviously be a rare one, since the stone must possess sufficiently stable equilibrium to prevent it from keeling over entirely, yet be unstable enough to make motion possible. The Bronx rocking stone is an unusually heavy one, standing well above the head of the person who would rock it. And now we learn of a similar rock down in the southern hemisphere, near Buenos Aires. In at least one respect this is more extraordinary than the New York stone, for the latter presents an entirely solid picture to the eye, and one would never suppose that it would rock until one had tried it; but the Argentine boulder looks as though the merest breath would topple it over into the valley below. This rocking stone is no small stone with regard to size, either; it is 24 feet high and 18 feet long, and is estimated to weigh somewhat more than 300 tons.



An unusually large rocking stone in the Argentine

Berlin's Forthcoming Skyscraper

WE have had it sufficiently impressed upon us that England and France are putting American ideas into operation in the manufacture of factory-made goods—the quantity-production methods of Mr. Ford and others like him are really taking hold on the other side of the ocean. Now it appears that even the Germans have filched a leaf out of Uncle Samuel's book, and that as a result the continent is going to see its first "cloud-scraper" as the German translation has it. The architect of Berlin in an effort to follow our lead is right up to the minute, too, and has stepped back his upper stories from his lower ones, exactly after the fashion made necessary by New York's new building laws, which restrict the height to which one may build over his entire plot while leaving him with more freedom over a part thereof. But he has gone us one better in the character of the lower block of his building, which as shown in the accompanying architect's drawing, is to be circular. We do not know how this structure will be received in Berlin or how it will look in its low-flung environs, but to our own eye, jaded by long contact with New York's two sky-lines and her numerous street canyons this curious shape makes a distinct appeal.



The architect's drawing for the front elevation of the first Continental skyscraper, about to go up in Berlin

New German Process of Preparing Flour

GERMAN traffic conditions are in such a bad state that the sending of grain for long distances to be ground in large mills is at present out of the question. Under these circumstances the grain must be both stored and ground in the locality where it is produced. One advantage of this method is that the grain can be stored without bags and can, therefore, be more conveniently handled; then, too, grain keeps much better than flour. A new system of producing flour adapted for use in small local mills has recently been devised in Germany; this is known as the Steinmetz system for cleaning and grinding grain. Instead of being ground when entirely dry as in the ordinary process, the grain is literally skinned in a moist condition, just as the skin is peeled off an almond when blanched.

This skin of a kernel of grain consists exteriorly of a permeable layer of ligneous fiber intended as an external means of mechanical protection and an inner integument which is impervious to water and is meant to keep the internal portion of the grain in a dry condition.

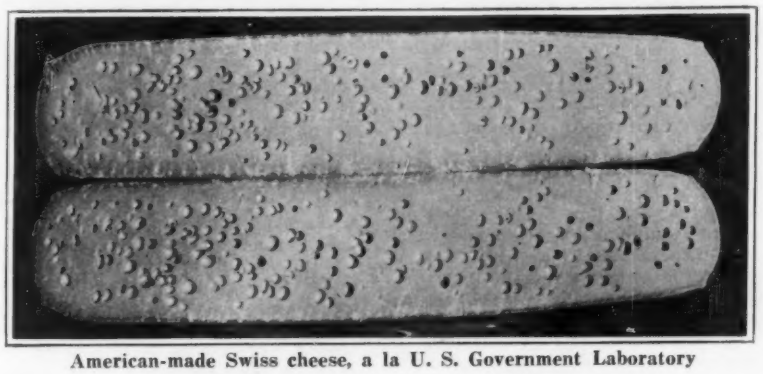
After this sort of intensive peeling and cleaning of the grain, it can be ground in a much simpler manner than when, as is the case in ordinary grinding, special care must be taken to keep the pure flour itself as free as possible from the imperfectly cleaned particles of the outer hull. The Steinmetz system employs for grinding vertical machines of the simplest type of construction. In this patented device the flour is hurled by means of the centrifugal force of the grindstone itself against the surrounding system of sieves, so that elaborate sifting machines become unnecessary. However, where such machines are already possessed there is no need of removing them, since they can be applied after the preliminary system of cleaning.

Contrary to the so-called whole-wheat system, which accomplishes the production of the so-called whole-wheat flour, the Steinmetz system merely produces dark grades and light grades of flour like ordinary mills.

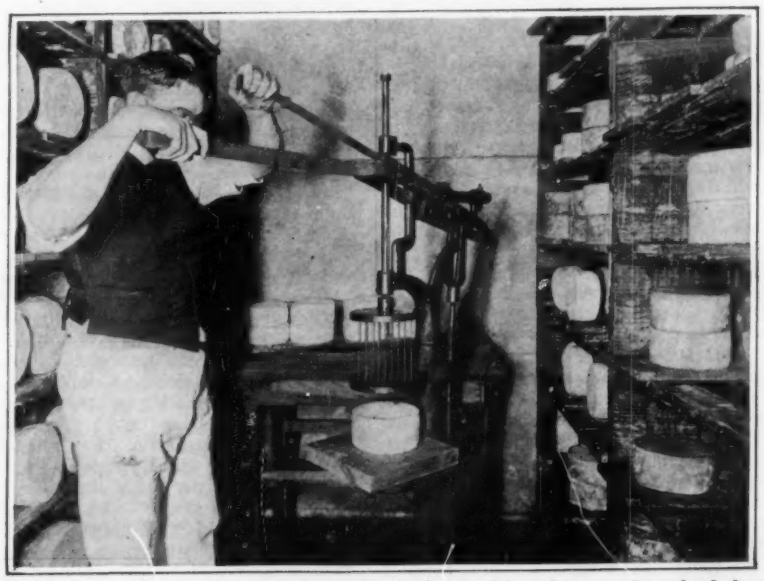
The Steinmetz system also includes a special process of baking, which in consequence of a new sort of construction of the baking forms, succeeds in accomplishing the always desirable slow baking of the dough. In consequence of the fact that the dough in this process is comparatively soft, the finished loaves have the best degree of lightness, it being easier to raise a soft dough than a stiff dough.

The entire process of cleansing and grinding the grain requires only five minutes, so that it is possible to have bread ready for consumption in three hours from the reaping of the grain. The bread has a peculiarly agreeable and "grainy" taste because of the absence of the foreign bacteria.

The baking forms or "pans" are made of clay with leaden bottoms which allow free access of heat to the dough, thus baking it thoroughly in the interior as well as upon the outside of the loaf.



American-made Swiss cheese, a la U. S. Government Laboratory



Not a jig for transmission covers, merely the machine that punches the holes in the Roquefort cheese made by Department of Agriculture investigators

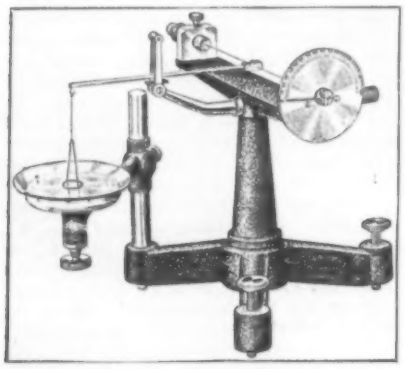
European Cheese Made in America

THERE is a joke, hoary with age, about the man who holds the responsible job of punching the holes in the Swiss cheeses. One of the illustrations herewith would indicate that there is about as much truth as fiction in this jest. The fact is, the experts of the Department of Agriculture, in their close investigation of the science of cheese-making with a view to making New York and Wisconsin, rather than Edam and Roquefort, the sources of American cheese supply, have learned a lot about cheeses, and incidentally a good deal about the holes therein. It seems that the holes, whether they appear in the finished product or not, are quite necessary during the intermediate stages of cheese formation, in order to permit of the proper circulation of air through the mass and the proper growth of the mold. Before the cheese is ripe the holes close up, but their work has been done.

The process in connection with which the particular punch which we illustrate is used is one for making first-class Roquefort cheese from cow's milk. It was always supposed that goat's milk was necessary for this, and it was believed that the proper conditions for the ripening of the cheeses were to be found only in certain caves of the district after which these cheeses take their name. But Uncle Sam's inquisitive chemists have learned by long investigation and repeated experiment that they can start with cow's milk, attain the desired conditions of temperature, moisture and air circulation for the curing process, and come out at the end with just as good Roquefort as ever carried a customs label.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts



This instrument determines the surface tension of any liquid and gives a direct reading on the dial

Testing the Surface Tension of Liquids

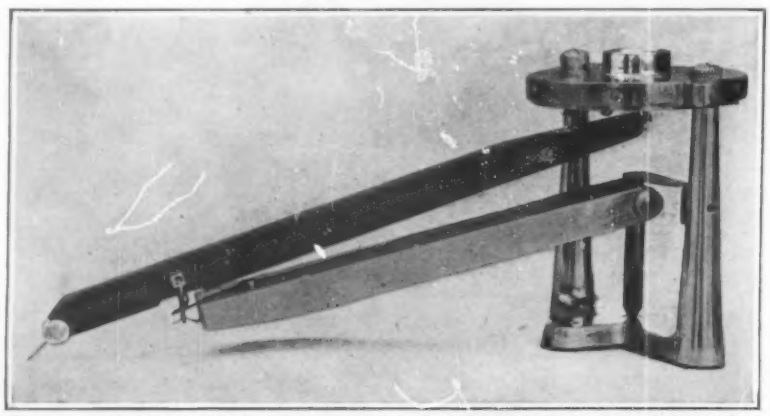
AN apparatus for measuring the surface tension or variation of surface tensions of a given liquid has been perfected by a Chicago manufacturer. The device is in reality a torsion balance and the torsion of the wire is used to counteract the tension of the liquid film and to break it. A single reading on a dial indicating the degree of torsion of the wire gives a figure, which if the instrument has previously been standardized with water, gives the surface tension of the liquid by a simple proportion.

The instrument consists of a stand provided at the top with a fine steel wire stretched between end supports. One end of the wire is tightly clamped while the other is attached to a worm wheel controlled by a thumb screw. To the worm wheel is attached a pointer which moves over a metal scale graduated in degrees. A hollow light aluminum lever with a small hook in the outer end is clamped to the middle of the wire. A stirrup is attached to the hook and carries a loop with a periphery of 4 centimeters in length. After placing this loop in contact with the liquid the pointer is set at zero and the torsion of the wire is gradually increased by the thumb screw till the loop of wire tears loose from the liquid.

The action of surface tension in biological phenomena is a very important study.

The Solid Tone-Arm

THOSE who believe that the ultimate phonograph will be on some principle differing from that found in the conventional hollow metal tone-arm will be interested in the experiments conducted during the past eighteen years by Mr. C. B. Repp of Plainfield, N. J. Mr. Repp conveys the tone vibrations through solid wood and string, eliminating the harsh metallic tone from instrumental music and the nasal twang from vocal pieces. He has constructed, of wood similar to that used in violins and aged by a special process, a solid tone-arm which he employs to carry the vibrations to a stationary sound-box. The wood arm is connected to the center of the disk in the sound-box by a linen string. The solid wood arm uses the conventional steel needle, but allows this to rest at an unusually low angle, which it is claimed permits an easier drag of the needle over the face of the record than is possible with the ordinary arrangement. This not alone is believed to lengthen the life of the record, but is stated also to reduce the surface noise.

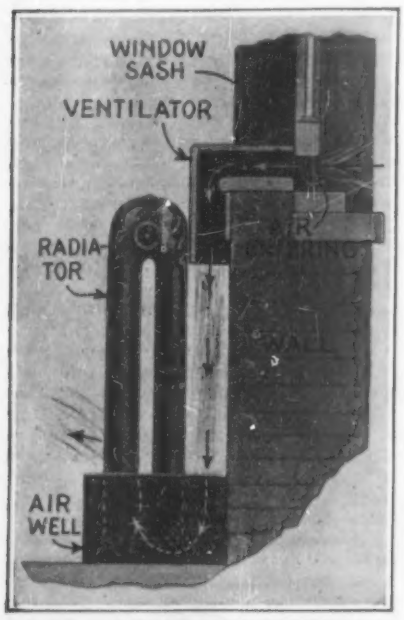


Tone-arm of solid wood, hooked to the center of the diaphragm by a linen string

A Partnership of Ventilator and Radiator

TO Commander J. E. Palmer, U.S.N., goes the credit for having invented what appears to be an ingenious system of ventilating and heating that is applicable wherever radiators are in use. Referring to the accompanying drawing, it will be noted that his system consists simply of a box arrangement at a partly open window to conduct the fresh air down behind a radiator where it becomes heated and thence dissipated into the room so that a person can sit close to the window without feeling the slightest draft.

The advantages of this system are said to be manifold. First, it is simple; secondly, it is automatic, requiring no attention other than raising or lowering the window so as to regulate the amount of air; third, it costs little to build. The operation is due to the outside air being cold and heavy, thus forcing itself through the open window and against the warm air of less density in the room. Its weight causes it to drop down behind the radiator, as indicated by the arrows. Once heated the fresh air rises out of the air well and is distributed throughout the room. This system was used most successfully for a whole winter in an office in the Navy Yard at Portsmouth, N. H., where the outside temperature was at times as low as 25 deg. below zero.



A patented system of drawing in outside air and warming it for ventilating purposes

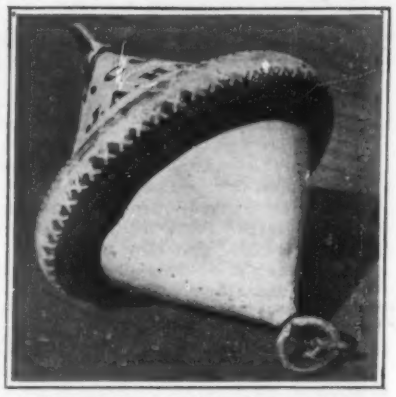
Advantages of Motor Crane

MANNED by a crew of three, an automobile crane consisting of a large crane mounted on a large chain driven truck chassis is capable of setting more telegraph or trolley poles than could be set by three gangs of men dependent on hand methods. Similar economies over manual operations are realized by using the motor crane equipped with a clamshell bucket for unloading bulk material from freight car to pile or from car to truck. Also on excavating jobs, which are not of sufficient magnitude to warrant the moving of a large and cumbersome steam shovel, this portable crane proves its worth. The crane itself follows the usual lines. It is of the full-swing, self-contained type, rotating through 360 degrees, and is driven by a separate, 4-cylinder gasoline motor which is built with an extra large flywheel so as to run smoothly in spite of sudden application and release of loads. The capacity of the crane is 8,000 lbs.

The particular advantage of this crane unit is its ability to move rapidly from place to place. This makes it especially adaptable for operations which must be undertaken quickly or for work of short duration where more time would be spent in transporting the customary steam-driven or crawler type to the site than in doing the work after arrival. Some of the special uses to which equipment of this type may be put are: Clearing streets of wreckage resulting from fire or collisions, handling trolley rails, and setting up heavy pieces of machinery.

An Out-of-the-Ordinary Use for Discarded Tires

THE latest novel use for discarded automobile tires to come to our attention is for small buoys. An aircraft company has been making buoys of the type shown in the accompanying illustration, in the construction of which a discarded automobile tire plays an important part. The tire, it will be noted, is placed about the main body of the buoy, to keep it afloat, thereby replacing the cork filling or other means generally employed to keep buoys above water. The automobile tire buoys are used for anchoring seaplanes and flying boats.



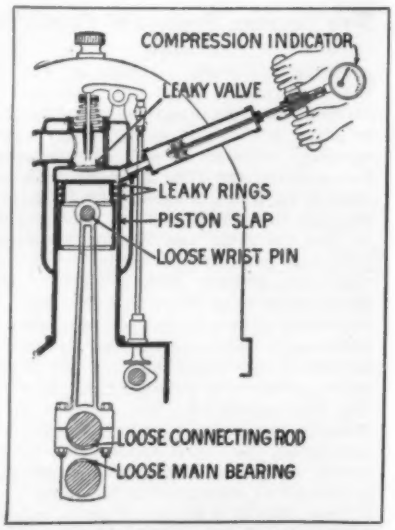
A discarded automobile tire used as a ring about a buoy to give it greater buoyancy

A Device for Locating Automobile Engine Troubles

SIXTEEN years' experience in automobile repairs has led E. A. Hammett of Kansas City, Mo., to invent a motor testing device, which, so he claims, locates loose wrist pins, piston slap, connecting rod and main bearing knocks, leaky valves and leaky piston rings, when the motor is not running and without taking the motor to pieces.

When the motor is running there are two distinct things taking place, namely, an explosion for power, and a vacuum for taking in another charge. Between these two effects we get our knocks. When the motor is in a firing position, but not running, the motor tester invented by Mr. Hammett is used to create alternately a vacuum and a compression in the firing chamber through the spark plug opening, which serves to indicate knocks and leaks in the motor. Each cylinder is tested separately, consequently the operator knows where and what the trouble is.

The accompanying sketch shows how the tester is used. Connection to the cylinder is made by screwing into the spark plug hole. To test compression, the tester handle is pushed down and the motor is turned two complete revolutions by hand. The gage then indicates the number of pounds compression in the cylinder. Other adjustments are made for testing for other troubles.



A simple device used in testing for all kinds of automobile engine troubles

California's Pinon-Nut Industry

(*Continued from page 7*)

ing for piñon-nut dishes. The two staples go together.

When the piñon cones or burrs begin to ripen and crack open, due to frost's effects, the nuts drop out like chestnuts. Then the Piutes spread their blankets under the trees and knock them off with clubs and poles. After this they are ingeniously cleaned by the squaws, who use fan-shaped willow baskets, tossing them in the wind until all the refuse is blown away. The more adept its user the larger the basket. The older women are expert and handle a bushel a day each with ease. The cleaning is followed by the necessary process of roasting. A pit is dug, a lot of rocks are heated, often by burning cones, thrown in, and the nuts spread over them and stirred until done. Only an Indian can do this properly. They dry out quickly after roasting and should be eaten within a few months. In the raw state they may be kept long in a dry, cool place. Many are sold unroasted and the consumer is the loser thereby because the white man cannot bring out their best qualities in the finest oven yet designed.

Each family or group of families caches its own supply, to be drawn as required, in cleverly-concealed places under rocks and leaves. Seldom do they steal from each other—never, before civilization was thrust upon them. Occasionally a white man stumbles upon a cache and helps himself. In the earlier days a few palefaces lost their scalps through looting caches.

A few years ago it was an easy matter to exchange a sack of flour for a sack of nuts, while a few biscuits would buy a considerable quantity, but the red man has become sophisticated. To offer him anything but real money is assurance that no nuts will be forthcoming. He understands monopoly like a war profiteer; he has learned all about the law of supply and demand.

The Indians grind the nuts into meal and make palatable bread and also a rich porridge. They go to extremes in eating. When they have to loosen their belts for comfort they give no thought to the days of possible emptiness ahead. Sometimes a dusky glutton will overload his stomach with the nuts and seek relief from the consequent pain by external rubbing with liniment made of the same thing that caused it. The friction aids digestion and the liniment gets the credit. Nobody has thought of patenting this "heap medicine."

The piñon nut contains an astonishingly high percentage of fat—61.9; protein, 14.6; ash, 2.8; carbohydrates, 17.3; water, 3.4. It has the high fuel value of 3,364 per pound, and is credited with tonic properties beneficial to the entire human system. Fugitives and men lost in the lofty California mountain wonderland have sustained life on it alone for months and come out in good condition.

Bridging the Delaware at Philadelphia

(*Continued from page 9*)

beams and some bracing were designed for high strength alloy steel. A medium carbon steel was used for remaining steel construction except the cable and hangers of the suspension bridge design. For these high carbon steel wire possessing even greater strength than that used in the New York suspension bridges is available. In No. 6 size (.192 inch diameter) this wire has an ultimate strength of 215,000 pounds per square inch and an elastic limit of over 144,000 pounds per square inch.

The report states that local conditions require that the cables be carried to an anchorage a considerable distance back of the towers and it is therefore economical to suspend the side spans from them. The cables and towers necessary for the main span sustain the fixed load of the side spans with but a very small increase in size and at little additional cost. It is desirable that the side spans be something less than half the main span in length.

The dimension which has the most important effect on the economy of design of a suspension bridge is that of the sag, or versed sine, given the cables. This dimension is the vertical distance between the highest point of the cable curve at the towers and its lowest point at midspan. On the choice of this depends the size of the cable, the height of the towers, the weight of the anchorage and the pressure on their foundations. The stresses in the stiffening trusses are also in great measure influenced by it. For this design 200 feet was chosen as the versed sine best suited to the requirements of the bridge and its economy.

By the simple expedient of placing the walkways on the upper lateral, bracing and grouping the vehicle and car roadways on the lower levels, the engineers considerably reduced the width of deck space. The roadway is inside the carlines. At first the engineers considered suspending the bridge from four main cables as in all the New York bridges. But this would involve a width between outside tower legs of 118 feet and main pier caissons 170 feet long. The two cable design adopted permits the two tower columns to be placed 89 feet apart and saves twenty-five per cent in the cost of main piers alone. It gives also a much more definite distribution of load to the cables.

This choice required a notable increase in the size of cables. Those in the Brooklyn Bridge are fifteen and three-quarter inches in diameter. The Williamsburg cables are eighteen and five-eighth inches, and the Manhattan twenty and a half inches. On the Delaware Bridge the size determined on is thirty inches. Despite the fifty per cent increase the manufacture and erection of the cables will involve no new or untried procedure, says the report. The wires will be laid in place individually and parallel to make up 61 strands, which will be subsequently bound together and wrapped with serving wire, to make up the complete cable of 16,500 wires. Every twenty and a half feet measured horizontally a circumferential cast steel saddle will be fastened to the cable, over which four galvanized wire ropes, two and five-eighth inches diameter each, will be hung to carry the suspended structure. The cables rest on cast steel saddles on the towers and at the anchorages. Back of the anchorage saddles they are fastened to anchor chains embedded in the mass of the anchorage masonry.

The stiffening trusses were computed according to the Deflection Theory, first used on the Manhattan Bridge. It is based on the behavior of the bridge as a composite structure and takes into account the part which the total weight of the structure plays in resisting the cable deformations. The stresses are computed for the specified moving load of 11,990 pounds per lineal foot, and a temperature range of 110 degrees, to cover all conditions of loading and temperature.

The report states that in the early suspension bridges, with small spans and light loads, masonry towers were mostly used. The Brooklyn Bridge, with its long span, has stone towers; but in all succeeding suspension bridges of that magnitude the towers have been built of steel. The reason for the departure from masonry is purely a matter of practical engineering. There is no doubt that well-proportioned masonry towers produce a fine aesthetic effect, but structurally they cannot satisfy the engineering requirements of a large bridge.

Under various conditions of loading the resting points of the cables on the tops of the towers are subject to considerable horizontal displacements. Formerly, it was common practice to place the cable saddles on roller beds, which were relied upon to permit this motion. Experience on large bridges has shown that the

rollers and saddles do not move until frictional resistance of considerable magnitude has been overcome. This means that the towers must bend to permit this horizontal displacement. The large dimensions which masonry towers require to sustain the enormous reaction of a long span bridge makes them unfit for bending. The necessary lateral width causes difficulty in securing sufficient clearances at the point where the roadway passes through the tower. The cables will be rigidly attached to the tops of the steel towers, this with a view to avoiding the uncertainty of response of the rollers. Hence the steel towers are so designed that they can safely deflect in the plane of the cables as much as may be required to permit a balancing of the horizontal forces. The proper proportioning to bring this about, when the towers are fixed at their base results in slender and graceful lines. The strength to withstand the bending stresses in addition to the direct stresses is provided by the addition of the proper amount of material.

The towers are 12 feet wide at the top parallel to the cables, widening to 40 feet at the base. Transversely the width is seven feet. The anchorage masonry is designed as a monolith. Each will require 90,700 cubic yards of masonry, and will rest on gravel strata, and on inclined caissons extending down to rock or other satisfactory material. The horizontal pull of the cables combined with the weight of the anchorage produces a resultant inclined to the verticle about one foot in six feet. To avoid any possible doubt as to resistance to sliding of the anchorage it is intended to sink 20 small caissons to hard foundation with the same inclination as the resultant of the forces.

A program of widened streets to meet the requirements of the new bridge also has been suggested by the engineers, based on a comprehensive traffic survey. The board reports that the bridge can be built by July 4, 1926, the Sesquicentennial of the Declaration of Independence. Plans are now well along in Philadelphia for celebrating this with a world's fair.

Rock suitable for foundations was found at 86.7 feet on the Philadelphia side and 91.6 feet on the Camden side below mean high water at the site opposite Franklin Square, two blocks north of Market Street, Philadelphia, recommended by the engineers for the bridge. At other sites considered, the rock level was near the practicable limit of pneumatic foundation work, exceeding on one side of the river or the other 110 feet, below which depth the engineers find that men can work only in half-hour shifts.

The Condensing of Milk

(*Continued from page 11*)

is a sturdy six-cylinder affair that pumps the milk under a pressure of 3,500 pounds through a series of minute passageways, and this serves to atomize the globules of butter fat, *i.e.*, cream, so effectually that they do not again combine but remain evenly distributed throughout the fluid. Until this machine was developed it was found that in a can of evaporated milk the lighter solids would rise to the top while the heavier ones settled to the bottom, and the purchaser often mistook this condition as a sign that something was wrong.

The preserved milk we have been describing is that commonly known as evaporated milk, and is unsweetened. As it is expelled from the homogenizer it is forced first through the coils of a water cooler and then on through the pipes of a brine cooler where its temperature drops to 45 degrees Fahrenheit. Coming from the latter refrigerating equipment it pours into enamel-lined tanks whence it is fed to the filling machines that charge the cans familiar to all of us. The cans when filled and sealed are carried to the sterilizing room where they are exposed to the heat of live steam for from thirty minutes to an hour at a temperature ranging from 226 to 240 degrees Fahrenheit.

The sterilizer is, in effect, a boiler in which is mounted a revolving wheel-like structure capable of holding 6,720 cans at a time. When this framework is loaded, the big iron cylinder is sealed, hot water is admitted until the sterilizer is nearly filled, and then steam is applied to bring the temperature up and to maintain it there for the desired period. With hot water and steam used so widely in a factory of the sort in question, it is not surprising that an expenditure of three gallons is required for every pound of milk condensed. Therefore, the water supply must be abundant and of unquestionable purity. When the sterilized cans of evaporated milk have cooled, they are then ready to be labeled mechanically, packed in boxes, and loaded aboard cars for shipment. It is entirely practicable to receive the raw milk in the morning and to dispatch the finished condensed milk in the afternoon.

"Preserved milk," *i.e.*, sweetened condensed milk, is not run through the homogenizer nor is it sterilized after canning. About 16 pounds of sugar is added to every 100 pounds of raw milk while the latter is in the hot wells or after the bulk of a charge has been drawn into a vacuum pan. The sugar content plays the part of a preservative and thus obviates the need of the protective treatment of sterilizing, and the sugar also prevents the separation in storage of the light and the heavy solids in the condensed commodity. But the use of sugar involves some very nice problems during the preparation of preserved milk, and the utmost care must be exercised to guard against "sandiness" due to the crystallization of some of the sugar. This grittiness does not really impair the product, but the public insists upon smoothness.

The avoidance of sandiness depends upon various things, *i.e.*, the manner in which the sugar is commingled with the "batch" of milk, the temperatures employed in the hot wells and the vacuum pans, and also the cooling processes relied upon in refrigerating the hot condensed milk when it is tapped from the vacuum pans. If the percentage of cane sugar fall below the requisite measure the result is a gelatinous milk or one that may spoil sooner or later; on the other hand, however, an excess of sugar, no matter how skilfully the condensing milk is handled, will, in all likelihood, induce sandiness. Needless to remark each manufacturer has his own ways of insuring a satisfactory outcome; and the raw milk obtained at the different seasons of the year imposes modifications in practice. One pound of the final product represents approximately two and a half pounds of fresh milk, and the water content averages about 30 per cent. Normally, milk has a water content of 87 per cent.

When the sweetened condensed milk has been run through the coolers, it is then led to glass-lined tanks from whence it is drawn off and supplied to the filling machines. The filling apparatus are designed so that their several cylinders will hold just enough milk to charge a corresponding number of cans; and in the course of a working day one of these machines will take care of 100,000 fifteen-ounce tins. Manifestly, in the preparation of both preserved and evaporated milk, the original bulk is reduced about one-half, and, similarly, the extraction of a large percentage of the water diminishes the weight greatly in proportion to the unit of remaining foodstuff. Therefore, results are realized that affect tremendously the space occupied and the weight to be dealt with during subsequent transportation and storage. In other words, when our condenseries turn out in a year a matter of substantially 2,031,000,000 pounds of concentrated milk—allowing for the sugar content in the sweetened class—the marketable commodity in the cans represents a saving in freight of quite 1,200,000 tons! At the same time they have conserved more than 4,504,000,000 pounds of an extremely perishable foodstuff and placed it within the reach of rich and poor everywhere.

Finally, it should be remarked that a steadily increasing percentage of the annual production of concentrated milk is what is known to the trade as "plain condensed milk," which is sold in bulk without being sterilized or preserved with sugar. Its keeping qualities, however, are greatly improved by the evaporation process to which it is subjected in the vacuum pans; and this milk, commonly shipped in 40-quart cans, is extensively used by confectioners and ice cream manufacturers. The condenseries, therefore, are contributing to the insistent and growing exactions of America's demand for sweets.

The Heavens for July, 1921

(*Continued from page 12*)

month, but is too near it to be seen. He passes through inferior conjunction on the 7th, and later comes into sight as a morning star, running out quickly to elongation on the 28th, when he rises at 3:30 A. M. He should be easy to see during the last week of the month.

Venus is a morning star, and reaches her greatest elongation on the 1st, 45° 44′ from the sun. She rises at 2 A. M., and is exceedingly conspicuous all this month.

Mars is just past conjunction with the sun, and, though theoretically a morning star, is practically invisible.

Jupiter and Saturn are both evening stars in Leo, only five degrees apart. On the 10th the former sets at 9:50 P. M., and the latter at 10:10. Jupiter is moving eastward faster than Saturn, and steadily drawing nearer to him; but the conjunction of the two will not occur until they are lost in the sun's rays. We still see the dark side of Saturn's rings, but they are turned more and more nearly edgewise toward us, and after August 3rd the bright side will come into view once more.

Uranus is in Aquarius, and comes to the meridian about 3 A. M. in the middle of the month. Neptune is in Cancer, and unobservable, setting less than two hours after the sun.

The moon is new at 10 A. M. on the 5th, in her first quarter at 11 P. M. on the 11th, full at 7 P. M. on the 19th, and in her last quarter at 9 P. M. on the 27th. She is nearest the earth on the 6th and farthest away on the 21st. During the month she is in conjunction with Venus on the 1st, when an occultation is visible in Europe, with Mars and Mercury on the 5th, Neptune on the 7th, Jupiter and Saturn on the 9th, Uranus on the 23rd, and Venus again on the 31st.

Comets

Winnecke's comet, of which we spoke last month, passed perihelion on June 13th, and was nearest the earth on the preceding day at a distance of about 14 million miles. By July 1st it will be almost twenty million miles from us, and rapidly receding. According to an accurate ephemeris, computed at the University of California, its apparent position will be on July 1st 0h. 32 m. R.A., Dec. 19° 55′ south; while on the 20th it will be in 1h. 21m. and 34° 27′ south. Unless some exceptional brightening takes place, it will be invisible to the naked eye all through the apparition, and will be only of the ninth or tenth magnitude in July.

Reid's comet, discovered at the Cape in March, is now rapidly receding and growing very faint.

A comet was discovered by Dubrage, in Russia, on April 29th. According to elements computed at Petrograd, it passed perihelion on May 7th, at a distance of 107 million miles from the sun. It is moving in a direct orbit, with an inclination of 22°. A plot of the orbit indicates that it should remain visible in the evening sky for some months, receding from the earth and sun and growing fainter. No ephemeris for the present month is at hand.

Mt. Wilson Observatory, June 11, 1921.

BEHIND THE SCENES

Behind the scenes — in the factories with the industrial engineers, in the laboratories side by side with chemists and research-workers, and out in the open with the problems of the world's highways and waterways — in the midst of it all goes the SCIENTIFIC AMERICAN publications.

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